# WEST

Help | Logout | Interrupt

Main Menu | Search Form | Posting Counts | Show S Numbers | Edit S Numbers | Preferences | Cases

### Search Results -

| Term | Documents |
|---|---|
| "6317619".DWPI,TDBD,EPAB,JPAB,USPT,PGPB. | 3 |
| 6317619S | 0 |
| "6317619".USPT,PGPB,JPAB,EPAB,DWPI,TDBD. | 3 |
| (6317619).USPT,PGPB,JPAB,EPAB,DWPI,TDBD. | 3 |

**Database:**
US Patents Full-Text Database
US Pre-Grant Publication Full-Text Database
JPO Abstracts Database
EPO Abstracts Database
Derwent World Patents Index
IBM Technical Disclosure Bulletins

**Search:** L21

Refine Search

Recall Text | Clear

### Search History

**DATE: Tuesday, December 17, 2002** Printable Copy Create Case

| Set Name side by side | Query | Hit Count | Set Name result set |
|---|---|---|---|
| | *DB=USPT,PGPB,JPAB,EPAB,DWPI,TDBD; PLUR=YES; OP=ADJ* | | |
| L21 | 6317619 | 3 | L21 |
| L20 | L18 not l19 | 38 | L20 |
| L19 | L18 and (fat$2) | 6 | L19 |
| L18 | L17 and (improv$6 or quality or resolution or resolv$9 or reduc$4 or minimiz$7 or precision) | 44 | L18 |
| L17 | L16 and (move or moving or moved or movement or motion) | 44 | L17 |
| L16 | L15 and (gradient) | 44 | L16 |
| L15 | L14 and (static$5 or uniform$6 or main or homogeneous or homogeneity) | 59 | L15 |
| L14 | L13 and (center$4 or iso-center$4 or isocenter$4 or align$6) | 69 | L14 |
| L13 | L12 and ((bed or couch or platform or stretcher or table or gantry or support) with (patient or object or subject)) | 76 | L13 |
| L12 | L11 and (FOV or "field of view" or field-of-view or (imaging with (region or volume or area or zone))) | 198 | L12 |
| L11 | L10 and (((new or another or second) with (position$4 or locat$4 or orient$8)) or (reposition$4 or relocat$4 or reorient$8 or re-position$4 or re-locat$4 or re-orient$8)) | 363 | L11 |
| L10 | L9 and (artifacts or distort$4 or non-uniform$5 or nonuniform$5 or "non uniform$5" or inhomogeneous or inhomogeneities or maxwell or pertub$6 or perturb$6 or (eddy with current) or ghost$4 or alias$4) | 495 | L10 |
| L9 | L8 and ("3d" or three-dimension$6 or 3-dimension$6 or "three dimension$6" or 3 dimension$6) | 776 | L9 |
| L8 | L7 and (zone or volume or area or region) | 1455 | L8 |
| L7 | L6 and (patient or subject or object) | 1498 | L7 |
| L6 | L5 and ((shift$4 or difference or chang$4) with (position$4 or locat$4 or orient$8)) | 1578 | L6 |
| L5 | L4 and (position$4 or locat$4 or orient$8) | 5006 | L5 |
| L4 | L3 and (fast or (high with speed) or rapid$3) | 5839 | L4 |
| L3 | L2 and (automatic$7 or auto-matic$7) | 9473 | L3 |
| L2 | L1 and (vertical$3 or horizontal$3 or up or down or rais$4 or lower$4 or left or right) | 110707 | L2 |
| L1 | ((magnetic adj resonance) or MRI or NMR) | 138284 | L1 |

END OF SEARCH HISTORY

# WEST

## Freeform Search

**Database:** US Patents Full-Text Database
US Pre-Grant Publication Full-Text Database
JPO Abstracts Database
EPO Abstracts Database
Derwent World Patents Index
IBM Technical Disclosure Bulletins

**Term:**

**Display:** 100 **Documents in Display Format:** - **Starting with Number** 1

**Generate:** ○ Hit List ◉ Hit Count ○ Side by Side ○ Image

Search | Clear | Help | Logout | Interrupt

Main Menu | Show S Numbers | Edit S Numbers | Preferences | Cases

### Search History

**DATE: Tuesday, December 17, 2002** Printable Copy Create Case

| Set Name side by side | Query | Hit Count | Set Name result set |
|---|---|---|---|
| | *DB=USPT,PGPB,JPAB,EPAB,DWPI,TDBD; PLUR=YES; OP=ADJ* | | |
| L20 | L18 not l19 | 38 | L20 |
| L19 | L18 and (fat$2) | 6 | L19 |
| L18 | L17 and (improv$6 or quality or resolution or resolv$9 or reduc$4 or minimiz$7 or precision) | 44 | L18 |
| L17 | L16 and (move or moving or moved or movement or motion) | 44 | L17 |
| L16 | L15 and (gradient) | 44 | L16 |
| L15 | L14 and (static$5 or uniform$6 or main or homogeneous or homogeneity) | 59 | L15 |
| L14 | L13 and (center$4 or iso-center$4 or isocenter$4 or align$6) | 69 | L14 |
| L13 | L12 and ((bed or couch or platform or stretcher or table or gantry or support) with (patient or object or subject)) | 76 | L13 |
| L12 | L11 and (FOV or "field of view" or field-of-view or (imaging with (region or volume or area or zone))) | 198 | L12 |
| L11 | L10 and (((new or another or second) with (position$4 or locat$4 or orient$8)) or (reposition$4 or relocat$4 or reorient$8 or re-position$4 or re-locat$4 or re-orient$8)) | 363 | L11 |
| L10 | L9 and (artifacts or distort$4 or non-uniform$5 or nonuniform$5 or "non uniform$5" or inhomogeneous or inhomogeneities or maxwell or pertub$6 or perturb$6 or (eddy with current) or ghost$4 or alias$4) | 495 | L10 |
| L9 | L8 and ("3d" or three-dimension$6 or 3-dimension$6 or "three dimension$6" or 3 dimension$6) | 776 | L9 |
| L8 | L7 and (zone or volume or area or region) | 1455 | L8 |
| L7 | L6 and (patient or subject or object) | 1498 | L7 |
| L6 | L5 and ((shift$4 or difference or chang$4) with (position$4 or locat$4 or orient$8)) | 1578 | L6 |
| L5 | L4 and (position$4 or locat$4 or orient$8) | 5006 | L5 |
| L4 | L3 and (fast or (high with speed) or rapid$3) | 5839 | L4 |
| L3 | L2 and (automatic$7 or auto-matic$7) | 9473 | L3 |
| L2 | L1 and (vertical$3 or horizontal$3 or up or down or rais$4 or lower$4 or left or right) | 110707 | L2 |
| L1 | ((magnetic adj resonance) or MRI or NMR) | 138284 | L1 |

END OF SEARCH HISTORY

Generate Collection Print

L20: Entry 23 of 38 File: USPT Nov 13, 2001

US-PAT-NO: 6317619
DOCUMENT-IDENTIFIER: US 6317619 B1

TITLE: Apparatus, methods, and devices for magnetic resonance imaging controlled by the position of a moveable RF coil

DATE-ISSUED: November 13, 2001

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Boernert; Peter | Hamburg | | | DE |
| Schaeffter; Tobias Richard | Hamburg | | | DE |
| Weiss; Steffen | Hamburg | | | DE |

ASSIGNEE-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY | TYPE CODE |
|---|---|---|---|---|---|
| U.S. Philips Corporation | New York | NY | | | 02 |

APPL-NO: 09/ 363349 [PALM]
DATE FILED: July 29, 1999

INT-CL: [07] A61 B 5/055

US-CL-ISSUED: 600/410; 600/422, 324/307, 324/309, 324/318
US-CL-CURRENT: 600/410; 324/307, 324/309, 324/318, 600/422

FIELD-OF-SEARCH: 600/410, 600/422, 600/423, 324/307, 324/309, 324/318, 324/322

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

Search Selected Search ALL

| PAT-NO | ISSUE-DATE | PATENTEE-NAME | US-CL |
|---|---|---|---|
| 5184074 | February 1993 | Kaufman et al. | |
| 5390673 | February 1995 | Kikinis | 128/653.2 |
| 5545993 | August 1996 | Taguchi et al. | 324/309 |
| 5715822 | February 1998 | Watkins et al. | 600/422 |
| 5800352 | September 1998 | Ferre et al. | 600/407 |
| 5830142 | November 1998 | Kuhara | 600/410 |
| 6011396 | January 2000 | Eckels et al. | 324/307 |

OTHER PUBLICATIONS

"Integrated and Interactive Position Tracking and Imaging of Interventional Tools and Internal Devices Using Small Fiducial Receiver Coils" by Glyn A. Coutts et al., in MRM 40: pp. 908-913, 1988.

ART-UNIT: 377

PRIMARY-EXAMINER: Smith; Ruth S.

ABSTRACT:

Objects of this invention include provision of magnetic resonance (MR) imaging methods, MR apparatus, and radio-frequency (RF) receiving coil devices permitting interactive MR examination of a patient. In particular, this invention includes means for generating MR images by a moveable RF coil which can be moved across a patient during an MR examination. The MR apparatus includes a position detection system which detects the current position and orientation of the moveable RF coil. The coil can be hand held for manual movement or can be attached to mechanical manipulators for controlled movement. The imaging methods determine and generate magnetic gradient and RF pulse sequences to excite nuclear magnetization in a 3D region determined with respect to the current 3D position and 3D orientation of the moveable RF coil. The invention also includes moveable RF coils for receiving and transmitting which are configured and sized for convenient manipulation by an operator. A preferable moveable RF coil assembly includes markers necessary to interact with a particular position detection system, display means for displaying reconstructed images in real-time, and control means for operator entry of signals controlling the MR apparatus. This invention also includes a carrier medium with recorded program instructions for controlling a programmable MR apparatus to perform the disclosed methods.

16 Claims, 8 Drawing figures

**Search Results** - Record(s) 1 through 38 of 38 returned.

1. Document ID: US 20020173715 A1

L20: Entry 1 of 38 File: PGPB Nov 21, 2002

PGPUB-DOCUMENT-NUMBER: 20020173715
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020173715 A1

TITLE: Method for acquiring MRI data from a large field of view using continuous table motion

PUBLICATION-DATE: November 21, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | COUNTRY | RULE-47 |
|---|---|---|---|---|
| Kruger, David G. | Nelson | WI | US | |
| Riederer, Stephen J. | Rochester | MN | US | |

US-CL-CURRENT: 600/410

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

2. Document ID: US 20020156365 A1

L20: Entry 2 of 38 File: PGPB Oct 24, 2002

PGPUB-DOCUMENT-NUMBER: 20020156365
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020156365 A1

TITLE: MRI-guided interventional mammary procedures

PUBLICATION-DATE: October 24, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | COUNTRY | RULE-47 |
|---|---|---|---|---|
| Tsekos, Nikolaos V. | Creve Coeur | MO | US | |

US-CL-CURRENT: 600/411; 600/417, 606/130

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

3. Document ID: US 20020145042 A1

L20: Entry 3 of 38 File: PGPB Oct 10, 2002

PGPUB-DOCUMENT-NUMBER: 20020145042
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020145042 A1

TITLE: Internet-based remote monitoring, configuration and service (RMCS) system capable of monitoring, configuring and servicing a planar laser illumination and imaging (PLIIM) based network

PUBLICATION-DATE: October 10, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | COUNTRY | RULE-47 |
|---|---|---|---|---|
| Knowles, C. Harry | Moorestown | NJ | US | |
| Schmidt, Mark C. | Williamstown | NJ | US | |
| Zhu, Xiaoxun | Marlton | NJ | US | |
| Defoney, Shawn | Runnemede | NJ | US | |
| Skypala, Edward | Blackwood | NJ | US | |
| Tsikos, Constantine J. | Voorhees | NJ | US | |
| Au, Ka Man | Philadelphia | PA | US | |
| Schwartz, Barry E. | Haddonfield | NJ | US | |
| Wirth, Allan | Bedford | MA | US | |
| Jankevics, Andrew | Westford | MA | US | |
| Good, Timothy A. | Clementon | NJ | US | |
| Ghosh, Sankar | Glenolden | PA | US | |
| Schnee, Michael D. | Aston | PA | US | |
| Kolis, George | Pennsauken | NJ | US | |
| Amundsen, Thomas | Turnersville | NJ | US | |
| Naylor, Charles A. | Sewell | NJ | US | |
| Blake, Robert | Woodbury Heights | NJ | US | |
| Dobbs, Russell Joseph | Cherry Hill | NJ | US | |
| Yorsz, Jeffery | Winchester | MA | US | |
| Giordano, Patrick A. | Blackwood | NJ | US | |
| Colavito, Stephen J. | Brookhaven | PA | US | |
| Wilz, David W. SR. | Sewell | NJ | US | |
| Svedas, William | Deptford | NJ | US | |
| Kim, Steven Y. | Cambridge | MA | US | |
| Fischer, Dale M. | Voorhees | NJ | US | |
| Tassell, Jon Van | Winchester | MA | US | |

US-CL-CURRENT: 235/462.01



---

☐ 4. Document ID: US 20020115929 A1

L20: Entry 4 of 38 File: PGPB Aug 22, 2002

PGPUB-DOCUMENT-NUMBER: 20020115929
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020115929 A1

TITLE: Magnetic resonance imaging for a plurality of selective regions set to object continuously moved

PUBLICATION-DATE: August 22, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | COUNTRY | RULE-47 |
|---|---|---|---|---|
| Machida, Yoshio | Nasu-Gun | | JP | |

US-CL-CURRENT: 600/410

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

## 5. Document ID: US 20020033854 A1

L20: Entry 5 of 38 File: PGPB Mar 21, 2002

PGPUB-DOCUMENT-NUMBER: 20020033854
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020033854 A1

TITLE: Printing cartridge with pressure sensor array identification

PUBLICATION-DATE: March 21, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | COUNTRY | RULE-47 |
|---|---|---|---|---|
| Silverbrook, Kia | Balmain | | AU | |

US-CL-CURRENT: 347/17; 347/19, 347/5

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

## 6. Document ID: US 20020030713 A1

L20: Entry 6 of 38 File: PGPB Mar 14, 2002

PGPUB-DOCUMENT-NUMBER: 20020030713
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020030713 A1

TITLE: Printing cartridge with two dimensional code identification

PUBLICATION-DATE: March 14, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | COUNTRY | RULE-47 |
|---|---|---|---|---|
| Silverbrook, Kia | Balmain | | AU | |

US-CL-CURRENT: 347/19; 347/5

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

## 7. Document ID: US 20020030712 A1

L20: Entry 7 of 38 File: PGPB Mar 14, 2002

PGPUB-DOCUMENT-NUMBER: 20020030712
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020030712 A1

TITLE: Printing cartridge with an integrated circuit device

PUBLICATION-DATE: March 14, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | COUNTRY | RULE-47 |
|---|---|---|---|---|
| Silverbrook, Kia | Balmain | | AU | |

US-CL-CURRENT: 347/19; 347/86

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

## 8. Document ID: US 20020021128 A1

L20: Entry 8 of 38 File: PGPB Feb 21, 2002

PGPUB-DOCUMENT-NUMBER: 20020021128
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020021128 A1

TITLE: Magnetic resonance imaging involving movement of patient's couch

PUBLICATION-DATE: February 21, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | COUNTRY | RULE-47 |
|---|---|---|---|---|
| Kuhara, Shigehide | Otawara-Shi | | JP | |

US-CL-CURRENT: 324/309; 324/307, 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

## 9. Document ID: US 20010001807 A1

L20: Entry 9 of 38 File: PGPB May 24, 2001

PGPUB-DOCUMENT-NUMBER: 20010001807
PGPUB-FILING-TYPE: new-utility
DOCUMENT-IDENTIFIER: US 20010001807 A1

TITLE: Radiotherapy machine including magnetic resonance imaging system

PUBLICATION-DATE: May 24, 2001

INVENTOR-INFORMATION:

| NAME | CITY | STATE | COUNTRY | RULE-47 |
|---|---|---|---|---|
| Green, Michael Curzon | Polo Alto | CA | US | |

US-CL-CURRENT: 600/411; 324/318, 378/65, 600/1, 600/415

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

## 10. Document ID: US 6484049 B1

L20: Entry 10 of 38 File: USPT Nov 19, 2002

US-PAT-NO: 6484049
DOCUMENT-IDENTIFIER: US 6484049 B1

TITLE: Fluoroscopic tracking and visualization system

DATE-ISSUED: November 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
| --- | --- | --- | --- | --- |
| Seeley; Teresa | Littleton | MA | | |
| Lin; Faith | Lexington | MA | | |
| Kapur; Tina | Andover | MA | | |
| Gregerson; Gene | Bolton | MA | | |

US-CL-CURRENT: 600/426; 600/427, 600/429, 600/431, 606/130

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC | Draw Desc | Image

---

11. Document ID: US 6476863 B1

L20: Entry 11 of 38 File: USPT Nov 5, 2002

US-PAT-NO: 6476863
DOCUMENT-IDENTIFIER: US 6476863 B1

TITLE: Image transformation means including user interface

DATE-ISSUED: November 5, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
| --- | --- | --- | --- | --- |
| Silverbrook; Kia | Sydney | | | AU |

US-CL-CURRENT: 348/231.9

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC | Draw Desc | Image

---

12. Document ID: US 6468265 B1

L20: Entry 12 of 38 File: USPT Oct 22, 2002

US-PAT-NO: 6468265
DOCUMENT-IDENTIFIER: US 6468265 B1

TITLE: Performing cardiac surgery without cardioplegia

DATE-ISSUED: October 22, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Evans; Philip C. | Portola Valley | CA | | |
| Moll; Frederic H. | Woodside | CA | | |
| Guthart; Gary S. | Foster City | CA | | |
| Nowlin; William C. | Los Altos | CA | | |
| Pendleton; Rand P. | Palo Alto | CA | | |
| Wilson; Christopher P. | La Honda | CA | | |
| Ramans; Andris D. | Mountain View | CA | | |
| Rosa; David J. | San Jose | CA | | |
| Falk; Volkmar | Woodside | CA | | |
| Younge; Robert G. | Portola Valley | CA | | |

US-CL-CURRENT: 606/1; 600/103, 600/229

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

☐ 13. Document ID: US 6459495 B1

L20: Entry 13 of 38 File: USPT Oct 1, 2002

US-PAT-NO: 6459495
DOCUMENT-IDENTIFIER: US 6459495 B1

TITLE: Dot center tracking in optical storage systems using ink dots

DATE-ISSUED: October 1, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Silverbrook; Kia | Sydney | | | AU |

US-CL-CURRENT: 358/520

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

☐ 14. Document ID: US 6442525 B1

L20: Entry 14 of 38 File: USPT Aug 27, 2002

US-PAT-NO: 6442525
DOCUMENT-IDENTIFIER: US 6442525 B1

TITLE: System for authenticating physical objects

DATE-ISSUED: August 27, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Silverbrook; Kia | Balmain NSW 2041 | | | AU |
| Walmsley; Simon Robert | Epping NSW 2121 | | | AU |
| Lapstun; Paul | Rodd Point NSW 2046 | | | AU |

US-CL-CURRENT: 705/1; 235/379, 235/380, 235/382, 348/441, 348/460, 348/552, 380/30, 705/51, 705/52, 705/64, 705/67, 705/71, 713/169, 713/180

Full | Title | Citation | Fro | Review | Classification | Date | Reference | Sequ s | Attachments | KWIC
Draw Desc | Image

☐ 15. Document ID: US 6431669 B1

L20: Entry 15 of 38 File: USPT Aug 13, 2002

US-PAT-NO: 6431669
DOCUMENT-IDENTIFIER: US 6431669 B1

TITLE: Method and apparatus for information storage in a portable print roll

DATE-ISSUED: August 13, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Silverbrook; Kia | Sydney | | | AU |

US-CL-CURRENT: 347/2; 358/296

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

☐ 16. Document ID: US 6416154 B1

L20: Entry 16 of 38 File: USPT Jul 9, 2002

US-PAT-NO: 6416154
DOCUMENT-IDENTIFIER: US 6416154 B1

TITLE: Printing cartridge with two dimensional code identification

DATE-ISSUED: July 9, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Silverbrook; Kia | Balmain | | | AU |

US-CL-CURRENT: 347/19; 347/14

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

☐ 17. Document ID: US 6415054 B1

L20: Entry 17 of 38 File: USPT Jul 2, 2002

US-PAT-NO: 6415054
DOCUMENT-IDENTIFIER: US 6415054 B1

TITLE: Target detection for dot region alignment in optical storage systems using ink dots

DATE-ISSUED: July 2, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | CODE | COUNTRY |
|---|---|---|---|---|
| Silverbrook; Kia | Sydney | | | AU |
| Walmsley; Simon Robert | Sydney | | | AU |

US-CL-CURRENT: 382/233

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

## ☐ 18. Document ID: US 6374132 B1

L20: Entry 18 of 38 File: USPT Apr 16, 2002

US-PAT-NO: 6374132
DOCUMENT-IDENTIFIER: US 6374132 B1

TITLE: MRI-guided therapeutic unit and methods

DATE-ISSUED: April 16, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Acker; David E. | Setauket | NY | | |
| Wagshul; Mark | Patchogue | NY | | |

US-CL-CURRENT: 600/411; 324/307, 324/309, 324/318, 601/2

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

## ☐ 19. Document ID: US 6366798 B2

L20: Entry 19 of 38 File: USPT Apr 2, 2002

US-PAT-NO: 6366798
DOCUMENT-IDENTIFIER: US 6366798 B2

TITLE: Radiotherapy machine including magnetic resonance imaging system

DATE-ISSUED: April 2, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Green; Michael Curzon | Palo Alto | CA | | |

US-CL-CURRENT: 600/411; 378/65, 600/1, 600/422

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

## ☐ 20. Document ID: US 6362869 B1

L20: Entry 20 of 38 File: USPT Mar 26, 2002

US-PAT-NO: 6362869
DOCUMENT-IDENTIFIER: US 6362869 B1

TITLE: Authentication system for camera print rolls

DATE-ISSUED: March 26, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
| --- | --- | --- | --- | --- |
| Silverbrook; Kia | Sydney | | | AU |

US-CL-CURRENT: 355/18; 347/101, 347/19

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

## 21. Document ID: US 6362868 B1

L20: Entry 21 of 38 File: USPT Mar 26, 2002

US-PAT-NO: 6362868
DOCUMENT-IDENTIFIER: US 6362868 B1

TITLE: Print media roll and ink replaceable cartridge

DATE-ISSUED: March 26, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
| --- | --- | --- | --- | --- |
| Silverbrook; Kia | Sydney | | | AU |

US-CL-CURRENT: 355/18; 347/86, 355/72, 399/12

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

## 22. Document ID: US 6356715 B1

L20: Entry 22 of 38 File: USPT Mar 12, 2002

US-PAT-NO: 6356715
DOCUMENT-IDENTIFIER: US 6356715 B1

TITLE: Prints remaining indicating for camera with variable length print capability

DATE-ISSUED: March 12, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
| --- | --- | --- | --- | --- |
| Silverbrook; Kia | Sydney | | | AU |

US-CL-CURRENT: 396/284; 347/101, 396/429, 396/515

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

## 23. Document ID: US 6317619 B1

L20: Entry 23 of 38 File: USPT Nov 13, 2001

US-PAT-NO: 6317619
DOCUMENT-IDENTIFIER: US 6317619 B1

TITLE: Apparatus, methods, and devices for magnetic resonance imaging controlled by the position of a moveable RF coil

DATE-ISSUED: November 13, 2001

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Boernert; Peter | Hamburg | | | DE |
| Schaeffter; Tobias Richard | Hamburg | | | DE |
| Weiss; Steffen | Hamburg | | | DE |

US-CL-CURRENT: 600/410; 324/307, 324/309, 324/318, 600/422

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

24. Document ID: US 6317192 B1

L20: Entry 24 of 38 File: USPT Nov 13, 2001

US-PAT-NO: 6317192
DOCUMENT-IDENTIFIER: US 6317192 B1

TITLE: Utilization of image tiling effects in photographs

DATE-ISSUED: November 13, 2001

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Silverbrook; Kia | Sydney | | | AU |
| Lapstun; Paul | Sydney | | | AU |
| Walmsley; Simon Robert | Sydney | | | AU |

US-CL-CURRENT: 355/18; 347/2, 348/222.1, 396/429

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

25. Document ID: US 6315200 B1

L20: Entry 25 of 38 File: USPT Nov 13, 2001

US-PAT-NO: 6315200
DOCUMENT-IDENTIFIER: US 6315200 B1

TITLE: Encoded data card reading system

DATE-ISSUED: November 13, 2001

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Silverbrook; Kia | Sydney | | | AU |
| Walmsley; Simon Robert | Sydney | | | AU |

US-CL-CURRENT: 235/454; 235/462.01, 235/462.1, 235/462.24, 235/470

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

☐ 26. Document ID: US 6298259 B1

L20: Entry 26 of 38 File: USPT Oct 2, 2001

US-PAT-NO: 6298259
DOCUMENT-IDENTIFIER: US 6298259 B1

TITLE: Combined magnetic resonance imaging and magnetic stereotaxis surgical apparatus and processes

DATE-ISSUED: October 2, 2001

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Kucharczyk; John | Minneapolis | MN | 55403 | |
| Gillies; George T. | Earlysville | VA | 22936-9590 | |

US-CL-CURRENT: 600/411; 324/307, 324/309, 324/310, 600/415, 600/417, 600/420, 600/429, 606/130

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

☐ 27. Document ID: US 6275722 B1

L20: Entry 27 of 38 File: USPT Aug 14, 2001

US-PAT-NO: 6275722
DOCUMENT-IDENTIFIER: US 6275722 B1

TITLE: Methods and apparatus for magnetic resonance imaging with RF coil sweeping

DATE-ISSUED: August 14, 2001

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Martin; Alastair | St. Louis Park | MN | | |
| Vaals Van; Joop | Best | | | NL |

US-CL-CURRENT: 600/410; 324/308, 324/318, 324/322, 600/411, 600/414, 600/422, 600/423, 606/130

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

☐ 28. Document ID: US 6217165 B1

L20: Entry 28 of 38 File: USPT Apr 17, 2001

US-PAT-NO: 6217165
DOCUMENT-IDENTIFIER: US 6217165 B1

TITLE: Ink and media cartridge with axial ink chambers

DATE-ISSUED: April 17, 2001

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
| --- | --- | --- | --- | --- |
| Silverbrook; Kia | Sydney | | | AU |

US-CL-CURRENT: 347/86

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

## ☐ 29. Document ID: US 6198957 B1

L20: Entry 29 of 38 File: USPT Mar 6, 2001

US-PAT-NO: 6198957
DOCUMENT-IDENTIFIER: US 6198957 B1

TITLE: Radiotherapy machine including magnetic resonance imaging system

DATE-ISSUED: March 6, 2001

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
| --- | --- | --- | --- | --- |
| Green; Michael Curzon | Palo Alto | CA | | |

US-CL-CURRENT: 600/411; 378/65, 600/1, 600/422

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

## ☐ 30. Document ID: US 6128522 A

L20: Entry 30 of 38 File: USPT Oct 3, 2000

US-PAT-NO: 6128522
DOCUMENT-IDENTIFIER: US 6128522 A

TITLE: MRI-guided therapeutic unit and methods

DATE-ISSUED: October 3, 2000

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
| --- | --- | --- | --- | --- |
| Acker; David E. | Setauket | NY | | |
| Wagshul; Mark | Patchogue | NY | | |

US-CL-CURRENT: 600/411; 335/298

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

## ☐ 31. Document ID: US 5833608 A

L20: Entry 31 of 38 File: USPT Nov 10, 1998

US-PAT-NO: 5833608
DOCUMENT-IDENTIFIER: US 5833608 A

TITLE: Magnetic determination of position and orientation

DATE-ISSUED: November 10, 1998

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Acker; David Ellis | Setauket | NY | | |

US-CL-CURRENT: 600/409; 324/260

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

32. Document ID: US 5692029 A

L20: Entry 32 of 38 File: USPT Nov 25, 1997

US-PAT-NO: 5692029
DOCUMENT-IDENTIFIER: US 5692029 A

TITLE: Detection of concealed explosives and contraband

DATE-ISSUED: November 25, 1997

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Husseiny; Abdo A. | LaPlace | LA | | |
| Stevens; Edwin D. | New Orleans | LA | | |
| Sabri; Zeinab A. | LaPlace | LA | | |

US-CL-CURRENT: 378/88; 378/86

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

33. Document ID: US 5602891 A

L20: Entry 33 of 38 File: USPT Feb 11, 1997

US-PAT-NO: 5602891
DOCUMENT-IDENTIFIER: US 5602891 A

TITLE: Imaging apparatus and method with compensation for object motion

DATE-ISSUED: February 11, 1997

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Pearlman; Justin D. | Brookline | MA | | |

US-CL-CURRENT: 378/62; 250/363.01, 250/369, 378/8, 378/901

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

34. Document ID: US 5600303 A

L20: Entry 34 of 38 File: USPT Feb 4, 1997

US-PAT-NO: 5600303
DOCUMENT-IDENTIFIER: US 5600303 A

TITLE: Detection of concealed explosives and contraband

DATE-ISSUED: February 4, 1997

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Husseiny; Abdo A. | LaPlace | LA | | |
| Stevens; Edwin D. | New Orleans | LA | | |
| Sabri; Zeinab A. | LaPlace | LA | | |

US-CL-CURRENT: 340/568.1; 378/57

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

35. Document ID: US 5515863 A

L20: Entry 35 of 38 File: USPT May 14, 1996

US-PAT-NO: 5515863
DOCUMENT-IDENTIFIER: US 5515863 A

TITLE: Gastrointestinal magnetic resonance imaging

DATE-ISSUED: May 14, 1996

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Damadian; Raymond V. | Woodbury | NY | | |

US-CL-CURRENT: 600/420

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

36. Document ID: US RE32619 E

L20: Entry 36 of 38 File: USPT Mar 8, 1988

US-PAT-NO: RE32619
DOCUMENT-IDENTIFIER: US RE32619 E

TITLE: Apparatus and method for nuclear magnetic resonance scanning and mapping

DATE-ISSUED: March 8, 1988

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Damadian; Raymond V. | Woodbury | NY | 11797 | |

US-CL-CURRENT: 600/410; 324/309, 600/415



---

37. Document ID: US 4689563 A

L20: Entry 37 of 38 File: USPT Aug 25, 1987

US-PAT-NO: 4689563
DOCUMENT-IDENTIFIER: US 4689563 A

TITLE: High-field nuclear magnetic resonance imaging/spectroscopy system

DATE-ISSUED: August 25, 1987

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Bottomley; Paul A. | Clifton Park | NY | | |
| Edelstein; William A. | Schenectady | NY | | |
| Hart, Jr.; Howard R. | Schenectady | NY | | |
| Schenck; John F. | Schenectady | NY | | |
| Redington; Rowland W. | Schenectady | NY | | |
| Leue; William M. | Albany | NY | | |

US-CL-CURRENT: 324/309



---

38. Document ID: US 4599565 A

L20: Entry 38 of 38 File: USPT Jul 8, 1986

US-PAT-NO: 4599565
DOCUMENT-IDENTIFIER: US 4599565 A

TITLE: Method and apparatus for rapid NMR imaging using multi-dimensional reconstruction techniques

DATE-ISSUED: July 8, 1986

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Hoenninger, III; John C. | Oakland | CA | | |
| Crooks; Lawrence E. | Richmond | CA | | |
| Arakawa; Mitsuaki | San Mateo | CA | | |
| Singer; Jerome R. | Berkeley | CA | | |

US-CL-CURRENT: 324/309



---

| Term | Documents |
| --- | --- |
| (18 NOT 19).USPT,PGPB,JPAB,EPAB,DWPI,TDBD. | 38 |
| (L18 NOT L19).USPT,PGPB,JPAB,EPAB,DWPI,TDBD. | 38 |

**Display Format:** - Change Format

Previous Page Next Page

# WEST

Generate Collection | Print

**Search Results** - Record(s) 1 through 3 of 3 returned.

☐ 1. Document ID: US 6429862 B1

L21: Entry 1 of 3 File: USPT Aug 6, 2002

US-PAT-NO: 6429862
DOCUMENT-IDENTIFIER: US 6429862 B1

TITLE: Three-dimensional image processing apparatus

DATE-ISSUED: August 6, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Teramoto; Fuyuhiko | Kashiwa | | | JP |

US-CL-CURRENT: 345/419

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

☐ 2. Document ID: US 6317619 B1

L21: Entry 2 of 3 File: USPT Nov 13, 2001

US-PAT-NO: 6317619
DOCUMENT-IDENTIFIER: US 6317619 B1

TITLE: Apparatus, methods, and devices for magnetic resonance imaging controlled by the position of a moveable RF coil

DATE-ISSUED: November 13, 2001

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Boernert; Peter | Hamburg | | | DE |
| Schaeffter; Tobias Richard | Hamburg | | | DE |
| Weiss; Steffen | Hamburg | | | DE |

US-CL-CURRENT: 600/410; 324/307, 324/309, 324/318, 600/422

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

☑ 3. Document ID: WO 200109633 A2 US 6317619 B1 EP 1145026 A2

L21: Entry 3 of 3 File: DWPI Feb 8, 2001

DERWENT-ACC-NO: 2002-089491
DERWENT-WEEK: 200212

TITLE: Generating magnetic resonance images, involves determining magnetic gradient and radio frequency pulses based on three=dimensional position and orientation relative to current position and orientation

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC

Drawi Desc | Clip Img | Image

Generate Collection | Print

| Term | Documents |
|---|---|
| "6317619".DWPI,TDBD,EPAB,JPAB,USPT,PGPB. | 3 |
| 6317619S | 0 |
| "6317619".USPT,PGPB,JPAB,EPAB,DWPI,TDBD. | 3 |
| (6317619).USPT,PGPB,JPAB,EPAB,DWPI,TDBD. | 3 |

**Display Format:** - | Change Format

Previous Page    Next Page

# WEST

## Freeform Search

| | |
|---|---|
| **Database:** | US Patents Full-Text Database<br>US Pre-Grant Publication Full-Text Database<br>JPO Abstracts Database<br>EPO Abstracts Database<br>Derwent World Patents Index<br>IBM Technical Disclosure Bulletins |
| **Term:** | L18 not l19 |
| **Display:** | 50 **Documents in Display Format:** - **Starting with Number** 1 |
| **Generate:** | ○ **Hit List** ◉ **Hit Count** ○ **Side by Side** ○ **Image** |

Search | Clear | Help | Logout | Interrupt

Main Menu | Show S Numbers | Edit S Numbers | Preferences | Cases

**Search History**

**DATE: Monday, June 17, 2002** Printable Copy Create Case

| Set Name side by side | Query | Hit Count | Set Name result set |
|---|---|---|---|
| | *DB=USPT,PGPB,JPAB,EPAB,DWPI,TDBD; PLUR=YES; OP=ADJ* | | |
| L20 | L18 not l19 | 26 | L20 |
| L19 | L18 and (fat$2) | 4 | L19 |
| L18 | L17 and (improv$6 or quality or resolution or resolv$9 or reduc$4 or minimiz$7 or precision) | 30 | L18 |
| L17 | L16 and (move or moving or moved or movement or motion) | 30 | L17 |
| L16 | L15 and (gradient) | 30 | L16 |
| L15 | L14 and (static$5 or uniform$6 or main or homogeneous or homogeneity) | 45 | L15 |
| L14 | L13 and (center$4 or iso-center$4 or isocenter$4 or align$6) | 53 | L14 |
| L13 | L12 and ((bed or couch or platform or stretcher or table or gantry or support) with (patient or object or subject)) | 59 | L13 |
| L12 | L11 and (FOV or "field of view" or field-of-view or (imaging with (region or volume or area or zone))) | 161 | L12 |
| L11 | L10 and (((new or another or second) with (position$4 or locat$4 or orient$8)) or (reposition$4 or relocat$4 or reorient$8 or re-position$4 or re-locat$4 or re-orient$8)) | 284 | L11 |
| L10 | L9 and (artifacts or distort$4 or non-uniform$5 or nonuniform$5 or "non uniform$5" or inhomogeneous or inhomogeneities or maxwell or pertub$6 or perturb$6 or (eddy with current) or ghost$4 or alias$4) | 387 | L10 |
| L9 | L8 and ("3d" or three-dimension$6 or 3-dimension$6 or "three dimension$6" or 3 dimension$6) | 602 | L9 |
| L8 | L7 and (zone or volume or area or region) | 1169 | L8 |
| L7 | L6 and (patient or subject or object) | 1208 | L7 |
| L6 | L5 and ((shift$4 or difference or chang$4) with (position$4 or locat$4 or orient$8)) | 1273 | L6 |
| L5 | L4 and (position$4 or locat$4 or orient$8) | 4230 | L5 |
| L4 | L3 and (fast or (high with speed) or rapid$3) | 4991 | L4 |
| L3 | L2 and (automatic$7 or auto-matic$7) | 8225 | L3 |
| L2 | L1 and (vertical$3 or horizontal$3 or up or down or rais$4 or lower$4 or left or right) | 101794 | L2 |
| L1 | ((magnetic adj resonance) or MRI or NMR) | 130202 | L1 |

END OF SEARCH HISTORY

# WEST

Generate Collection | Print

**Search Results -** Record(s) 1 through 4 of 4 returned.

---

☐ 1. Document ID: US 20020071104 A1

L19: Entry 1 of 4 File: PGPB Jun 13, 2002

PGPUB-DOCUMENT-NUMBER: 20020071104
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020071104 A1

TITLE: Image sensing apparatus including a microcontroller

PUBLICATION-DATE: June 13, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | COUNTRY | RULE-47 |
|---|---|---|---|---|
| Silverbrook, Kia | Balmain | | AU | |

US-CL-CURRENT: 355/18

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw. Desc | Image

---

☐ 2. Document ID: US 6064208 A

L19: Entry 2 of 4 File: USPT May 16, 2000

US-PAT-NO: 6064208
DOCUMENT-IDENTIFIER: US 6064208 A

TITLE: Two-peak alignment method of field shimming

DATE-ISSUED: May 16, 2000

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Steckner; Michael | Mayfield Heights | OH | | |

US-CL-CURRENT: 324/320; 324/300, 324/319

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw. Desc | Image

---

☐ 3. Document ID: US 5897495 A

L19: Entry 3 of 4 File: USPT Apr 27, 1999

US-PAT-NO: 5897495
DOCUMENT-IDENTIFIER: US 5897495 A

TITLE: Ultrasonic wave medical treatment apparatus suitable for use under guidance of magnetic resonance imaging

DATE-ISSUED: April 27, 1999

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Aida; Satoshi | Tokyo | | | JPX |
| Shibata; Mariko | Kanagawa-ken | | | JPX |
| Fujimoto; Katsuhiko | Kanagawa-ken | | | JPX |
| Ishibashi; Yoshiharu | Tokyo | | | JPX |
| Suzuki; Takuji | Kanagawa-ken | | | JPX |
| Ishihara; Yasutoshi | Kanagawa-ken | | | JPX |
| Okamoto; Kazuya | Saitama-ken | | | JPX |

US-CL-CURRENT: 600/411; 601/4

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

☐ 4. Document ID: US 5590653 A

L19: Entry 4 of 4 File: USPT Jan 7, 1997

US-PAT-NO: 5590653
DOCUMENT-IDENTIFIER: US 5590653 A

TITLE: Ultrasonic wave medical treatment apparatus suitable for use under guidance of magnetic resonance imaging

DATE-ISSUED: January 7, 1997

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Aida; Satoshi | Tokyo | | | JPX |
| Shibata; Mariko | Kanagawa-ken | | | JPX |
| Fujimoto; Katsuhiko | Kanagawa-ken | | | JPX |
| Ishibashi; Yoshiharu | Tokyo | | | JPX |
| Suzuki; Takuji | Kanagawa-ken | | | JPX |
| Ishihara; Yasutoshi | Kanagawa-ken | | | JPX |
| Okamoto; Kazuya | Saitama-ken | | | JPX |

US-CL-CURRENT: 600/411; 600/415, 600/427, 600/437, 601/3, 601/4

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

Generate Collection | Print

| Term | Documents |
|---|---|
| FAT$2 | 0 |
| FAT.DWPI,TDBD,EPAB,JPAB,USPT,PGPB. | 91764 |
| FATA.DWPI,TDBD,EPAB,JPAB,USPT,PGPB. | 343 |
| FATAA.DWPI,TDBD,EPAB,JPAB,USPT,PGPB. | 1 |
| FATAE.DWPI,TDBD,EPAB,JPAB,USPT,PGPB. | 1 |
| FATAH.DWPI,TDBD,EPAB,JPAB,USPT,PGPB. | 21 |
| FATAI.DWPI,TDBD,EPAB,JPAB,USPT,PGPB. | 12 |
| FATAL.DWPI,TDBD,EPAB,JPAB,USPT,PGPB. | 16048 |
| FATAN.DWPI,TDBD,EPAB,JPAB,USPT,PGPB. | 119 |
| FATAP.DWPI,TDBD,EPAB,JPAB,USPT,PGPB. | 1 |
| FATAR.DWPI,TDBD,EPAB,JPAB,USPT,PGPB. | 13 |
| (L18 AND (FAT$2)).USPT,PGPB,JPAB,EPAB,DWPI,TDBD. | 4 |

There are more results than shown above. Click here to view the entire set.

**Display Format:** - Change Format

Previous Page Next Page

# WEST

Generate Collection | Print

**Search Results -** Record(s) 1 through 26 of 26 returned.

☐ 1. Document ID: US 20020033854 A1

L20: Entry 1 of 26 File: PGPB Mar 21, 2002

PGPUB-DOCUMENT-NUMBER: 20020033854
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020033854 A1

TITLE: Printing cartridge with pressure sensor array identification

PUBLICATION-DATE: March 21, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | COUNTRY | RULE-47 |
|---|---|---|---|---|
| Silverbrook, Kia | Balmain | | AU | |

US-CL-CURRENT: 347/17; 347/19, 347/5

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

☐ 2. Document ID: US 20020030713 A1

L20: Entry 2 of 26 File: PGPB Mar 14, 2002

PGPUB-DOCUMENT-NUMBER: 20020030713
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020030713 A1

TITLE: Printing cartridge with two dimensional code identification

PUBLICATION-DATE: March 14, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | COUNTRY | RULE-47 |
|---|---|---|---|---|
| Silverbrook, Kia | Balmain | | AU | |

US-CL-CURRENT: 347/19; 347/5

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

☐ 3. Document ID: US 20020030712 A1

L20: Entry 3 of 26 File: PGPB Mar 14, 2002

PGPUB-DOCUMENT-NUMBER: 20020030712

PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020030712 A1

TITLE: Printing cartridge with an integrated circuit device

PUBLICATION-DATE: March 14, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | COUNTRY | RULE-47 |
|---|---|---|---|---|
| Silverbrook, Kia | Balmain | | AU | |

US-CL-CURRENT: 347/19; 347/86

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

☑ 4. Document ID: US 20020021128 A1

L20: Entry 4 of 26 File: PGPB Feb 21, 2002

PGPUB-DOCUMENT-NUMBER: 20020021128
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020021128 A1

TITLE: Magnetic resonance imaging involving movement of patient's couch

PUBLICATION-DATE: February 21, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | COUNTRY | RULE-47 |
|---|---|---|---|---|
| Kuhara, Shigehide | Otawara-Shi | | JP | |

US-CL-CURRENT: 324/309; 324/307, 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

☐ 5. Document ID: US 20010001807 A1

L20: Entry 5 of 26 File: PGPB May 24, 2001

PGPUB-DOCUMENT-NUMBER: 20010001807
PGPUB-FILING-TYPE: new-utility
DOCUMENT-IDENTIFIER: US 20010001807 A1

TITLE: Radiotherapy machine including magnetic resonance imaging system

PUBLICATION-DATE: May 24, 2001

INVENTOR-INFORMATION:

| NAME | CITY | STATE | COUNTRY | RULE-47 |
|---|---|---|---|---|
| Green, Michael Curzon | Polo Alto | CA | US | |

US-CL-CURRENT: 600/411; 324/318, 378/65, 600/1, 600/415

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

## ☐ 6. Document ID: US 6374132 B1

L20: Entry 6 of 26 File: USPT Apr 16, 2002

US-PAT-NO: 6374132
DOCUMENT-IDENTIFIER: US 6374132 B1

TITLE: MRI-guided therapeutic unit and methods

DATE-ISSUED: April 16, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Acker; David E. | Setauket | NY | | |
| Wagshul; Mark | Patchogue | NY | | |

US-CL-CURRENT: 600/411; 324/307, 324/309, 324/318, 601/2

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

## ☐ 7. Document ID: US 6366798 B2

L20: Entry 7 of 26 File: USPT Apr 2, 2002

US-PAT-NO: 6366798
DOCUMENT-IDENTIFIER: US 6366798 B2

TITLE: Radiotherapy machine including magnetic resonance imaging system

DATE-ISSUED: April 2, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Green; Michael Curzon | Palo Alto | CA | | |

US-CL-CURRENT: 600/411; 378/65, 600/1, 600/422

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

## ☐ 8. Document ID: US 6362869 B1

L20: Entry 8 of 26 File: USPT Mar 26, 2002

US-PAT-NO: 6362869
DOCUMENT-IDENTIFIER: US 6362869 B1

TITLE: Authentication system for camera print rolls

DATE-ISSUED: March 26, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
| --- | --- | --- | --- | --- |
| Silverbrook; Kia | Sydney | | | AUX |

US-CL-CURRENT: 355/18; 347/101, 347/19

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw. Desc | Image

## 9. Document ID: US 6362868 B1

L20: Entry 9 of 26 File: USPT Mar 26, 2002

US-PAT-NO: 6362868
DOCUMENT-IDENTIFIER: US 6362868 B1

TITLE: Print media roll and ink replaceable cartridge

DATE-ISSUED: March 26, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
| --- | --- | --- | --- | --- |
| Silverbrook; Kia | Sydney | | | AUX |

US-CL-CURRENT: 355/18; 347/86, 355/72, 399/12

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw. Desc | Image

## 10. Document ID: US 6356715 B1

L20: Entry 10 of 26 File: USPT Mar 12, 2002

US-PAT-NO: 6356715
DOCUMENT-IDENTIFIER: US 6356715 B1

TITLE: Prints remaining indicating for camera with variable length print capability

DATE-ISSUED: March 12, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
| --- | --- | --- | --- | --- |
| Silverbrook; Kia | Sydney | | | AUX |

US-CL-CURRENT: 396/284; 347/101, 396/429, 396/515

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw. Desc | Image

## 11. Document ID: US 6317619 B1

L20: Entry 11 of 26 File: USPT Nov 13, 2001

US-PAT-NO: 6317619
DOCUMENT-IDENTIFIER: US 6317619 B1

TITLE: Apparatus, methods, and devices for magnetic resonance imaging controlled by the position of a moveable RF coil

DATE-ISSUED: November 13, 2001

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Boernert; Peter | Hamburg | | | DEX |
| Schaeffter; Tobias Richard | Hamburg | | | DEX |
| Weiss; Steffen | Hamburg | | | DEX |

US-CL-CURRENT: 600/410; 324/307, 324/309, 324/318, 600/422

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

## 12. Document ID: US 6317192 B1

L20: Entry 12 of 26 File: USPT Nov 13, 2001

US-PAT-NO: 6317192
DOCUMENT-IDENTIFIER: US 6317192 B1

TITLE: Utilization of image tiling effects in photographs

DATE-ISSUED: November 13, 2001

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Silverbrook; Kia | Sydney | | | AUX |
| Lapstun; Paul | Sydney | | | AUX |
| Walmsley; Simon Robert | Sydney | | | AUX |

US-CL-CURRENT: 355/18; 347/2, 348/222, 396/429

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

## 13. Document ID: US 6315200 B1

L20: Entry 13 of 26 File: USPT Nov 13, 2001

US-PAT-NO: 6315200
DOCUMENT-IDENTIFIER: US 6315200 B1

TITLE: Encoded data card reading system

DATE-ISSUED: November 13, 2001

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Silverbrook; Kia | Sydney | | | AUX |
| Walmsley; Simon Robert | Sydney | | | AUX |

US-CL-CURRENT: 235/454; 235/462.01, 235/462.1, 235/462.24, 235/470

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

## 14. Document ID: US 6298259 B1

L20: Entry 14 of 26 File: USPT Oct 2, 2001

US-PAT-NO: 6298259
DOCUMENT-IDENTIFIER: US 6298259 B1

TITLE: Combined magnetic resonance imaging and magnetic stereotaxis surgical apparatus and processes

DATE-ISSUED: October 2, 2001

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Kucharczyk; John | Minneapolis | MN | 55403 | |
| Gillies; George T. | Earlysville | VA | 22936-9590 | |

US-CL-CURRENT: 600/411; 324/307, 324/309, 324/310, 600/415, 600/417, 600/420, 600/429, 606/130

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

## 15. Document ID: US 6275722 B1

L20: Entry 15 of 26 File: USPT Aug 14, 2001

US-PAT-NO: 6275722
DOCUMENT-IDENTIFIER: US 6275722 B1

TITLE: Methods and apparatus for magnetic resonance imaging with RF coil sweeping

DATE-ISSUED: August 14, 2001

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Martin; Alastair | St. Louis Park | MN | | |
| Vaals Van; Joop | Best | | | NLX |

US-CL-CURRENT: 600/410; 324/308, 324/318, 324/322, 600/411, 600/414, 600/422, 600/423, 606/130

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

## 16. Document ID: US 6217165 B1

L20: Entry 16 of 26 File: USPT Apr 17, 2001

US-PAT-NO: 6217165
DOCUMENT-IDENTIFIER: US 6217165 B1

TITLE: Ink and media cartridge with axial ink chambers

DATE-ISSUED: April 17, 2001

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Silverbrook; Kia | Sydney | | | AUX |

US-CL-CURRENT: 347/86

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

## 17. Document ID: US 6198957 B1

L20: Entry 17 of 26 File: USPT Mar 6, 2001

US-PAT-NO: 6198957
DOCUMENT-IDENTIFIER: US 6198957 B1

TITLE: Radiotherapy machine including magnetic resonance imaging system

DATE-ISSUED: March 6, 2001

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Green; Michael Curzon | Palo Alto | CA | | |

US-CL-CURRENT: 600/411; 378/65, 600/1, 600/422

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

## 18. Document ID: US 6128522 A

L20: Entry 18 of 26 File: USPT Oct 3, 2000

US-PAT-NO: 6128522
DOCUMENT-IDENTIFIER: US 6128522 A

TITLE: MRI-guided therapeutic unit and methods

DATE-ISSUED: October 3, 2000

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Acker; David E. | Setauket | NY | | |
| Wagshul; Mark | Patchogue | NY | | |

US-CL-CURRENT: 600/411; 335/298

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

☐ 19. Document ID: US 5833608 A

L20: Entry 19 of 26 File: USPT Nov 10, 1998

US-PAT-NO: 5833608
DOCUMENT-IDENTIFIER: US 5833608 A

TITLE: Magnetic determination of position and orientation

DATE-ISSUED: November 10, 1998

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Acker; David Ellis | Setauket | NY | | |

US-CL-CURRENT: 600/409; 324/260

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

☐ 20. Document ID: US 5692029 A

L20: Entry 20 of 26 File: USPT Nov 25, 1997

US-PAT-NO: 5692029
DOCUMENT-IDENTIFIER: US 5692029 A

TITLE: Detection of concealed explosives and contraband

DATE-ISSUED: November 25, 1997

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Husseiny; Abdo A. | LaPlace | LA | | |
| Stevens; Edwin D. | New Orleans | LA | | |
| Sabri; Zeinab A. | LaPlace | LA | | |

US-CL-CURRENT: 378/88; 378/86

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

☐ 21. Document ID: US 5602891 A

L20: Entry 21 of 26 File: USPT Feb 11, 1997

US-PAT-NO: 5602891

DOCUMENT-IDENTIFIER: US 5602891 A

TITLE: Imaging apparatus and method with compensation for object motion

DATE-ISSUED: February 11, 1997

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Pearlman; Justin D. | Brookline | MA | | |

US-CL-CURRENT: 378/62; 250/363.01, 250/369, 378/8, 378/901

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

☐ 22. Document ID: US 5600303 A

L20: Entry 22 of 26 File: USPT Feb 4, 1997

US-PAT-NO: 5600303
DOCUMENT-IDENTIFIER: US 5600303 A

TITLE: Detection of concealed explosives and contraband

DATE-ISSUED: February 4, 1997

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Husseiny; Abdo A. | LaPlace | LA | | |
| Stevens; Edwin D. | New Orleans | LA | | |
| Sabri; Zeinab A. | LaPlace | LA | | |

US-CL-CURRENT: 340/568.1; 378/57

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

---

☐ 23. Document ID: US 5515863 A

L20: Entry 23 of 26 File: USPT May 14, 1996

US-PAT-NO: 5515863
DOCUMENT-IDENTIFIER: US 5515863 A

TITLE: Gastrointestinal magnetic resonance imaging

DATE-ISSUED: May 14, 1996

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Damadian; Raymond V. | Woodbury | NY | | |

US-CL-CURRENT: 600/420

| Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC |
|---|---|---|---|---|---|---|---|---|---|---|
| Draw Desc | Image | | | | | | | | | |

---

☐ 24. Document ID: US RE32619 E

L20: Entry 24 of 26 File: USPT Mar 8, 1988

US-PAT-NO: RE32619
DOCUMENT-IDENTIFIER: US RE32619 E

TITLE: Apparatus and method for nuclear magnetic resonance scanning and mapping

DATE-ISSUED: March 8, 1988

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Damadian; Raymond V. | Woodbury | NY | 11797 | |

US-CL-CURRENT: 600/410; 324/309, 600/415

| Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC |
|---|---|---|---|---|---|---|---|---|---|---|
| Draw Desc | Image | | | | | | | | | |

---

☐ 25. Document ID: US 4689563 A

L20: Entry 25 of 26 File: USPT Aug 25, 1987

US-PAT-NO: 4689563
DOCUMENT-IDENTIFIER: US 4689563 A

TITLE: High-field nuclear magnetic resonance imaging/spectroscopy system

DATE-ISSUED: August 25, 1987

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Bottomley; Paul A. | Clifton Park | NY | | |
| Edelstein; William A. | Schenectady | NY | | |
| Hart, Jr.; Howard R. | Schenectady | NY | | |
| Schenck; John F. | Schenectady | NY | | |
| Redington; Rowland W. | Schenectady | NY | | |
| Leue; William M. | Albany | NY | | |

US-CL-CURRENT: 324/309

| Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC |
|---|---|---|---|---|---|---|---|---|---|---|
| Draw Desc | Image | | | | | | | | | |

---

☐ 26. Document ID: US 4599565 A

L20: Entry 26 of 26 File: USPT Jul 8, 1986

US-PAT-NO: 4599565

DOCUMENT-IDENTIFIER: US 4599565 A

TITLE: Method and apparatus for rapid NMR imaging using multi-dimensional reconstruction techniques

DATE-ISSUED: July 8, 1986

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---|---|---|---|---|
| Hoenninger, III; John C. | Oakland | CA | | |
| Crooks; Lawrence E. | Richmond | CA | | |
| Arakawa; Mitsuaki | San Mateo | CA | | |
| Singer; Jerome R. | Berkeley | CA | | |

US-CL-CURRENT: 324/309

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC

Draw Desc | Image

Generate Collection | Print

| Term | Documents |
|---|---|
| (18 NOT 19).USPT,PGPB,JPAB,EPAB,DWPI,TDBD. | 26 |
| (L18 NOT L19).USPT,PGPB,JPAB,EPAB,DWPI,TDBD. | 26 |

**Display Format:** - Change Format

Previous Page Next Page

L20: Entry 17 of 26 File: USPT Mar 6, 2001

DOCUMENT-IDENTIFIER: US 6198957 B1
TITLE: Radiotherapy machine including magnetic resonance imaging system

Abstract Paragraph Left (1):
A radiotherapy machine beam treats a region of a subject while the region and volumes abutting the region are imaged by a magnetic resonance imaging system. The beam and an excitation coil assembly of the imaging system are arranged so the beam is not incident on the coil assembly and magnetic fields derived from the coil assembly do not interact with the beam. The excitation coil assembly includes two spaced winding segments for producing a main DC magnetic field; the segments are located on opposite sides of the region. In one embodiment, wherein the excitation coil assembly is mounted independently of movement of an axis of the beam, the winding segments have a common axis generally aligned with an axis about which the beam axis turns. A treatment couch for the subject fits within aligned central openings of the winding segments. The coil produces main magnetic field lines that extend generally in the same direction as the axis about which the beam turns. In other embodiments, the coil assembly moves with the beam axis and the treatment couch is between the coil segments. In one such embodiment, each winding segment includes a central opening (1) through which the beam axis extends; and (2) generally aligned with magnetic field lines established by and extending between the segments. In another such embodiment, the beam axis extends through a space between the segments, being generally orthogonal to magnetic field lines established by and extending between the segments.

Brief Summary Paragraph Right (1):
The present invention relates generally to methods of and devices for treating a region of a subject with a radiotherapy beam and more particularly to such a method and device wherein the region is irradiated by the beam substantially simultaneously with a magnetic resonance imaging system imaging the region.

Brief Summary Paragraph Right (2):
Radiotherapy machines, such as the CLINAC machines manufactured by the assignee of the present invention, generally include a linear electron beam accelerator mounted on a gantry which rotates on an approximately horizontal axis. The electron beam accelerator is usually mounted on the gantry in such a manner that it is offset from the horizontal rotational axis of the gantry. The high energy electron beam emerging from the accelerator is further processed by techniques well-known to those experienced in the art to produce either an electron beam or an X-ray beam suitable for patient treatment. In either case the radiation is collimated in a treatment beam which is caused to travel in a direction perpendicular to the rotational axis of the gantry in such a manner that the axis of the treatment beam intersects the rotational axis of the gantry. The point at which the axis of the treatment beam intersects the rotational axis of the gantry is the focal point of the treatment beam and is referred to as the isocenter of the radiotherapy machine.

Brief Summary Paragraph Right (3):
In a radiotherapy machine the patient is placed on a treatment couch that can be precisely positioned to locate the treatment region, which is usually a cancerous tumor or lesion in the patient, on the rotational axis of the gantry at the isocenter of the radiotherapy machine. Thus, by rotating the gantry, the source of the treatment beam can be rotated around the patient during treatment, thereby minimizing the amount of treatment radiation passing through any one region of the patient's body near the treatment region while the beam always passes through the treatment region itself. Excessive irradiation of non-diseased tissue, especially those tissues abutting the diseased treatment region, causes undesirable cell damage

and cell death in healthy tissue.

Brief Summary Paragraph Right (4):
Among practitioners of current radiotherapy treatment art it is well-known that minimum abutting cell damage generally occurs when the diseased treatment region in the patient is precisely located at the isocenter of the radiotherapy machine. However, several limitations of the present art make it difficult to achieve the desired precise positioning of the diseased region of the patient at the isocenter of the radiotherapy machine.

Brief Summary Paragraph Right (5):
One reason for this difficulty is that diseased tissue in a patient usually is surrounded by, or is adjacent to, other soft tissue which is materially similar to the diseased tissue. The similarity of the tissues makes it difficult to precisely define the exact boundaries of the diseased tissue using current diagnostic and imaging techniques appropriate for radiotherapy machines.

Brief Summary Paragraph Right (6):
One past attempt to overcome this problem has involved using relatively low contrast two-dimensional X-ray-based imaging of the region when the subject is positioned on the radiotherapy machine. The X-ray-based imaging systems have generally relied on detecting X-rays in the same X-ray beam which is used for radiotherapy purposes. However, low contrast two-dimensional X-ray-based imaging of the region does not enable the true position of the region including the tumor or lesion to be definitely located. The difference in X-ray absorbance between different soft tissue structures and between cancerous and non-cancerous soft tissues frequently ranges from small to undetectable. Only the bones, which absorb X-rays more strongly, can be readily imaged and precisely located by this means. Determining the true position of the soft tissue region to be treated is difficult because due to its lack of rigidity the region moves relative to the nearby bones of the subject as a result of unavoidable body movements of the subject on the treatment couch. The uncertainty in determining the true position of the region exists even when fiducial markers are inserted into the tumor because patient movement is likely to cause the fiducial markers to move.

Brief Summary Paragraph Right (7):
Because the region desired to be treated is usually not located exactly as planned with respect to the isocenter of the radiotherapy system, insufficient quantities of radiotherapy beam energy are deposited in the region desired to be treated and excessive amounts of radiotherapy beam energy are deposited in healthy tissue in a volume abutting the region desired to be treated. Consequently, the tissue in the abutting volume is subjected to undesired and unnecessary damage so healthy organs adjacent the tumor site are damaged.

Brief Summary Paragraph Right (8):
Because of the general inability to focus the radiotherapy beam with sufficient precision on the region desired to be treated, current medical practice is to increase the irradiated area to include additional tissue volume and to increase the dosage of the radiotherapy beam to ensure complete cell death in the region desired to be treated. The expectation is that all cells in the treated region are killed and possible positioning errors between the beam and the region are compensated. However, such techniques inevitably cause increased collateral radiation damage to the volume abutting the desired region to be treated, in some cases resulting in devastating quality of life effects on the subject. It is, accordingly, an object of the present invention to provide a new and improved method of, and apparatus for enabling a radiotherapy beam to be accurately positioned on a desired region to be treated by the beam.

Brief Summary Paragraph Right (9):
Another object of the invention is to provide a new and improved method of, and apparatus for enabling a radiotherapy beam to be precisely positioned on a region desired to be treated, wherein the apparatus used to determine whether the beam is properly located is easily retrofitted on existing radiotherapy devices.

Brief Summary Paragraph Right (10):
An additional object of the invention is to provide a radiotherapy machine including a magnetic resonance imaging system for acquiring 2D and 3D spatially resolved high-contrast images of soft tissue structures and organs within and abutting the region desired to be treated.

Brief Summary Paragraph Right (11):
An additional object of the invention is to provide a radiotherapy machine including a magnetic resonance imaging system, wherein an excitation coil assembly of the imaging system is arranged so that a radiotherapy beam of the radiotherapy machine is not incident on the coil assembly and wherein the coil assembly is arranged so subjects to be treated can easily be placed in the path of the radiotherapy beam, on a treatment couch.

Brief Summary Paragraph Right (12):
An additional object of the invention is to provide a new and improved radiotherapy machine in combination with a system for directly detecting the effect of the radiotherapy beam on an irradiated region, particularly the contents of tissue cells in the region, and to spatially resolve the effect of the irradiation to enable real time three-dimensional correlation between the shape, position and intensity of the region actually being irradiated and the known location of a region desired to be irradiated, where a tumor or lesion is located.

Brief Summary Paragraph Right (13):
A further object of the invention is to provide a new and improved radiotherapy machine in combination with a relatively low cost device for determining whether, and the degree to which tissue in a region desired to be treated by a radiotherapy beam is actually being treated.

Brief Summary Paragraph Right (14):
Still a further object of the invention is to provide a new and improved X-ray beam therapy device in combination with a magnetic resonance imaging system, wherein secondary electron skin dosage resulting from bombardment of the skin by the X-ray beam is substantially reduced by the magnetic field of the coils of the imaging system.

Brief Summary Paragraph Right (15):
In accordance with one aspect of the present invention, these and other objects are achieved by treating a region of a subject with a radiotherapy beam while the region and volumes abutting the region are imaged by a magnetic resonance imaging system. The beam and an excitation coil assembly of the imaging system are arranged so the beam is not incident on the coil assembly and also so that magnetic fields derived from the coil assembly do not perturb the particle trajectories in the beam in the case where the radiotherapy beam is composed of charged particles such as electrons.

Brief Summary Paragraph Right (16):
The excitation coil assembly of the imaging system preferably includes first and second spaced segments for producing a main DC magnetic field; the segments are located on opposite sides of the region.

Brief Summary Paragraph Right (17):
In one embodiment, wherein the excitation coil assembly is mounted independently of movement of the treatment beam axis, the first and second excitation coil assembly segments have a common axis substantially coincident with an axis that passes through the region to be treated and about which the beam axis turns. A subject carrying structure, e.g., a treatment couch, fits within aligned central openings of the coil segments. The beam axis passes between the two segments at right angles to the main magnetic field lines produced by and extending between the segments.

Brief Summary Paragraph Right (18):
In other embodiments, the coil assembly is mounted so it moves as the beam axis moves.

Brief Summary Paragraph Right (19):
In one of these embodiments, each of the first and second coil segments includes a central opening having a common axis. The beam axis extends through the central openings of both coil segments and is generally aligned with magnetic field lines established by and extending between these segments. In another embodiment, the beam axis extends through a space between the segments and is generally at right angles to magnetic field lines established by and extending between the segments. The latter arrangement, which does not have a central opening in the coil segments, is advantageous because it establishes a higher intensity magnetic field than the arrangements with such an opening.

Brief Summary Paragraph Right (20):
A feature of the invention is that the magnetic field derived from the excitation coils of the magnetic resonance imaging system is relatively low, sufficient to provide only the minimum necessary spatial resolution and sensitivity for determining whether the radiotherapy beam is incident on the desired region to be treated. The magnetic field density is sufficiently low that conventional copper-wound water cooled coils can be employed to generate the main magnetic field, although superconducting magnetic coil assemblies, cooled to a liquid helium or liquid nitrogen temperature, can be employed if desired.

Brief Summary Paragraph Right (21):
If a liquid helium-cooled superconducting coil generates the magnetic resonance imaging system main magnetic field, commercially available high temperature superconducting supply leads preferably establish external connections between the superconducting coil and a DC power supply for exciting the superconducting coil. The high temperature superconducting supply leads block heat leakage from the liquid nitrogen temperature at which they are maintained, i.e., 77.degree. K, to the low temperature superconducting coil at 4.2.degree. K. Thereby, the low temperature superconducting coil is not required for reasons of heat leakage to operate in the persistent mode without supply leads connected, hence the current in the coil can be pulsed on and off by an external supply without an unacceptable increase in liquid helium consumption. By pulsing the high temperature superconductor supply leads on and off synchronously with pulsing an electron radiotherapy beam off and on, the magnetic resonance imaging system has no adverse deflection effects on electrons in the radiotherapy electron beam.

Brief Summary Paragraph Right (22):
To reduce the required strength of the magnetic field derived from the resonance imaging system magnetic coils, a radio frequency pickup coil of the resonance imaging system is preferably a superconductor. This enables the main magnetic coil of the resonance imaging system to have a relatively small size, to facilitate retrofitting the main coil to existing radiotherapy machines and reduce the cost of a facility including the structure of the invention. The superconducting radio frequency coil is preferably a high temperature superconductor formed from oriented high temperature superconducting films grown on metal foils or on planar oxide single crystal substrates. A further feature of the invention is that leakage magnetic fields originating in the radiotherapy machine are decoupled from magnetic fields originating in the magnetic resonance imaging system and leakage magnetic fields originating in the magnetic resonance imaging system are decoupled from the radiotherapy linear accelerator. The decoupling is preferably provided by compensating coils positioned outside the imaging system coils and by a coil or coils surrounding the linear accelerator and its associated components.

Brief Summary Paragraph Right (23):
A feature of the present invention is the capability of the magnetic resonance imaging system to detect changes in nuclear magnetic resonance spectral parameters of the image region due to the effects of the radiotherapy beam irradiating the tissue desired to be treated by the beam.

Brief Summary Paragraph Right (24):
At thermal equilibrium in a magnetic field, the magnetic moment of a nucleus is aligned with the magnetic field. When perturbed from this alignment, the magnetic moment precesses around the applied field at the characteristic resonance frequency of the particular nuclear species (often a hydrogen nucleus or proton). The variation of the applied magnetic field at different atomic sites in a molecule due to the shielding effects of the surrounding electrons causes small shifts in the resonance frequencies of similar nuclei. The nature of the environment of the resonating nuclei determines the rate at which the resonance decays, or relaxes. These differences in resonance frequencies can be resolved and used to analyze molecular structures. Alternatively, the resonance frequencies can be modified by the imposition of a magnetic field gradient across a sample in which case the resonance frequency is a function of the position of a particular nuclear spin within the sample. This forms the basis of nuclear magnetic resonance imaging systems.

Brief Summary Paragraph Right (25):
In either case, application of an rf pulse with a frequency close to that of the natural resonance frequency of the spins is used to perturb the nuclear magnetic

moment. The perturbation rotates the nuclear magnetic moment away from its alignment with the applied magnetic field. A rotation of 90.degree. produces a maximum magnetization transverse to the magnetic field while a 180.degree. rotation results in an inversion of the initial magnetization but no transverse magnetization. It is the transverse component of magnetization which precesses about the applied magnetic field and which can be detected in an NMR spectrometer. Following a perturbation, two relaxation times characterize the return to thermal equilibrium. In addition to precessing, the transverse magnetization decreases in amplitude with a characteristic time constant T2, the spin-spin relaxation time. The component of magnetization parallel to the applied field returns to its initial value with a characteristic time constant T1, the spin-lattice relaxation time. Both of these relaxation times are affected by the magnetic influences of neighboring atoms and molecules. In particular, the presence of free radicals with their strong electronic magnetic moment can modify the relaxation times and resonance frequencies of nearby nuclei. The measurement of resonance frequencies and relaxation times can be combined with NMR imaging methods to provide NMR spectral data which is correlated with spatial position.

Brief Summary Paragraph Right (26):
Because of the high sensitivity of the NMR spectral parameters to differences in the magnetic environment of nuclei in different types of soft tissue i.e. between the tissues in different body organs or between cancerous and non-cancerous tissues, the NMR image of soft tissue structures achieves much greater contrast than an X-ray image of the same tissue volume. Additionally the MR image contains 3D rather than 2D positional information. The position of the cancerous tumor or lesion in the soft tissue can therefore be determined directly on the radiotherapy machine with much greater precision than by inferring the presumed position of the tumor with reference to the position of the nearby bones obtained from an X-ray image.

Brief Summary Paragraph Right (27):
In addition, because of the large change in NMR spectral parameters induced by the presence of free radicals, which are one of the primary products of the irradiation of tissues by the radiotherapy beam, both the spatial location and the intensity of the irradiation effects of the radiation therapy beam on the tissues within the imaged volume can be determined in real time during treatment.

Brief Summary Paragraph Right (28):
In accordance with an aspect of the present invention, the analytical capability of a magnetic resonance imaging system is used to detect changes in nuclear magnetic resonance spectral parameters due to effects of the radiotherapy beam irradiating the tissue. The radiotherapy beam incident on selected tissue causes free radicals and ionization products to be produced in the tissue. The presence of these can be detected and imaged. The radiotherapy beam, the high intensity magnetic fields and the rf pulse of the magnetic resonance imaging system thus interact to enable three-dimensional spatial distribution information to be derived for the radiation dose of the radiotherapy beam deposited in the treated and abutting tissue during the treatment process. The three-dimensional information is derived by using known magnetic resonance imaging techniques and by correlating the detected data with the beam axis position and the known beam cross-sectional geometry and intensity. The three-dimensional information relating to the spatial distribution of the radiotherapy beam on the treated tissue is correlated with previously gathered and therefore known three-dimensional data concerning the position of the cancerous tissue desired to be treated. Thereby, the radiotherapy beam can be confined to the tissue desired to be treated and controlled so it is not incident on the abutting tissue. This enables the total radiation dose to the subject from the beam to be reduced and collateral damage to healthy tissue minimized. An MR image in absence of radiation will show cancerous tissue. With the beam on, the MR image will show the extent of tissue being irradiated.

Brief Summary Paragraph Right (29):
The above and still further objects, features and advantages of the present invention will become apparent upon consideration of the following detailed description of specific embodiments thereof, especially when taken in conjunction with the accompanying drawings.

Drawing Description Paragraph Right (2):
FIG. 2 is a side view of a radiotherapy machine, in combination with spaced stationary DC excitation coil segments of a magnetic resonance imaging system, wherein (1) a radiotherapy beam axis is generally at right angles to the direction

of main magnetic flux lines extending between the spaced segments, (2) a treated region of a subject is in a space between the segments, and (3) the segments include a central opening to accommodate the subject;

Drawing Description Paragraph Right (4):
FIG. 4 is a side view of a radiotherapy machine, in combination with spaced DC excitation coil segments of a magnetic resonance imaging system, wherein (1) the segments are mounted so an axis of a radiotherapy beam goes through a central opening of the segments, in general alignment, with main magnetic field lines extending between the segments, (2) a treated region of the subject is in a space between the segments, and (3) the segments include a central opening to accommodate the beam;

Drawing Description Paragraph Right (6):
FIG. 6 is a side view of a further embodiment of the present invention, wherein (1) spaced DC excitation coil segments of a magnetic resonance imaging system move with a radiotherapy beam axis and are arranged so main magnetic field fines derived from the coil segments are generally at right angles to the radiotherapy beam axis, (2) the treatment region is between the two coil segments, and (3) the segments do not have a central opening;

Drawing Description Paragraph Right (8):
FIG. 8 is a top view of a portion of the apparatus illustrated in FIG. 6, particularly of the position of X, Y, and Z axis gradient coils of the magnetic resonance imaging system;

Drawing Description Paragraph Right (9):
FIG. 9 is a top view of the apparatus illustrated in FIG. 6, wherein a coil segment of the magnetic resonance imaging system is turned 90.degree. to enable ease of access by a patient to the treatment couch of the radiotherapy device;

Drawing Description Paragraph Right (10):
FIG. 10 is a side view of the magnetic resonance imaging coil of FIG. 6, in combination with a coil arrangement for substantially canceling leakage magnetic fields from the coil;

Drawing Description Paragraph Right (11):
FIG. 11 is a side view of an optional configuration that can be used with the radiotherapy machines and the magnetic resonance imaging system of FIGS. 5 and 6, wherein a treatment couch carrying a subject to be treated by the radiotherapy machine is moved on non-magnetic tracks from one of several waiting positions to an operative position at the radiotherapy machine; and

Detailed Description Paragraph Right (1):
Reference is now made to the block diagram of FIG. 1, wherein the apparatus of the present invention is illustrated as including a relatively conventional radiotherapy machine 20, a magnetic resonance imaging system 22 and controller 24 for devices included in machine 20 and system 22. Radiotherapy machine 20 includes a radiotherapy beam source, in the form of an X-ray beam or pulsed electron beam source 26, a gantry for carrying source 26, drive motor 28 for the gantry, and a treatment couch on which a subject (patient) is located. The treatment couch includes a subject receiving bed that is selectively positioned in the horizontal plane along X and Z axis directions and in the vertical, Y axis direction; horizontal and vertical movements of the bed are provided by horizontal and vertical drive motors 31, 33 and 35. Radiotherapy machine 20 also includes coil 30 which encircles the linear accelerator and substantially cancels external leakage magnetic fields associated with the linear accelerator so these leakage fields do not have an effect on the operation of magnetic resonance imaging system 22.

Detailed Description Paragraph Right (2):
Magnetic resonance imaging system 22 includes a main DC magnetic coil assembly 32 having two spaced winding segments between which is located a region to be treated by the radiotherapy beam. The winding segments of assembly 32 are supplied with DC current by source 36 to produce the main magnetic DC field of system 22. Magnetic coil assembly 32 is positioned to produce a main DC magnetic field in the region of the subject at the location of the tissues desired to be destroyed by the radiotherapy beam of machine 20. The magnitude of the DC magnetic field produced by assembly 32 is sufficient to precess protons of body tissue cells of the subject in the region. Assembly 32 can include copper wire wound water cooled winding segments

(to minimize the cost of system 22) or high temperature superconducting winding segments cooled by a liquid nitrogen source or low temperature wire winding segments cooled to liquid helium temperatures by liquid helium source 34.

Detailed Description Paragraph Right (4):
If the low temperature superconducting coils are employed in assembly 32 to generate the main magnetic field of imaging system 22, the coils of assembly 32 are preferably connected to source 36 by high temperature superconducting leads 38, formed of commercially available materials. Leads 38, being maintained at a superconducting temperature of 77.degree. K by liquid nitrogen source 40, block heat leakage from source 36 to the 4.2.degree. K superconducting coils of assembly 32 so the coils of assembly 32 are not required to operate in a persistent mode. Since the coils of assembly 32 need not be operated in the persistent mode, the coils can be pulsed on and off, as is necessary if the beam of radiotherapy machine 20 is an electron beam. If the radiotherapy beam of machine 20 is an electron beam, the electron beam must be pulsed and the magnetic fields of imaging system 22 must be pulsed off when the electron beam is produced, so the imaging system magnetic fields do not deflect the electron beam charge carriers.

Detailed Description Paragraph Right (5):
Magnetic resonance imaging system 22 also includes rf coil 42 which excites protons in the imaged region treated by the radiotherapy beam so the protons precess at a frequency determined by (1) the atoms containing the protons; and (2) the magnitude of the magnetic fields where the protons are located. Rf coil 42 is either a conventional wire wound coil or is a high temperature superconductor, cooled to liquid nitrogen temperatures or a low temperature superconductor, cooled to a temperature close to that of liquid helium.

Detailed Description Paragraph Right (6):
Rf coil 42 is supplied with rf energy by pulsed rf source 44 which derives short duration pulses having a carrier frequency related to the precessing frequency of protons in the imaged and treated region. Rf receiver 46 responds to rf energy from the precessed protons and coupled back to coil 42 after the pulse from source 44 has subsided. The frequency of the energy coupled by coil 32 to receiver 46 is determined by the precessing frequency of protons in the region of the subject exposed to the DC magnetic fields of system 22, and the types of atoms in the region of the subject coupled to the magnetic fields derived from imaging system 22. By employing rf excitation pulses from rf source 44 to align the spins and then using delayed probe pulses to monitor the time-dependent signal amplitude at the various precession frequencies, it is possible to derive the relaxation times T1 and T2. Appropriate pulse sequences to accomplish this have been developed by those skilled in the art of magnetic resonance imaging. For example an 180.degree. excitation pulse to align the spins followed by a 90.degree. probe pulse may be employed to measure T1 and a 90.degree. excitation pulse to align the spins followed by a 180.degree. probe pulse may be used to monitor T2. More complex pulse sequences well known to those skilled in the art are employed to improve sensitivity and accuracy and these are combined with established signal processing techniques to provide a spatially resolved image where the pixels are weighted according to the local values of the relaxation times. Since the precessing frequency of protons in the imaged and treated region and in particular the values of the relaxation time parameters T1 and T2 are affected by the irradiation products of the radiotherapy beam, the frequency and the time-dependent amplitude of the rf energy coupled back to coil 42 is a function of whether or not the radiotherapy beam is incident on the imaged tissue.

Detailed Description Paragraph Right (7):
The rf receiver 46 supplies an rf signal to spectrometer of unit 48 and display unit 48. The spectrometer preferably combines the capability of fast Fourier transform analysis of chemical shift spectra employed in chemical nuclear magnetic resonance systems with the T1 and T2 relaxation time measurement capability and gradient coil driving electronics of magnetic resonance imaging systems, while the display is of the three-dimensional type usually used in magnetic resonance imaging systems. Thereby, spectrometer and display unit 48 includes a fast Fourier transform computer program to determine the frequency content of the rf energy coupled by coil 42 to receiver 46.

Detailed Description Paragraph Right (8):
Because spectrometer and display unit 48 includes a fast Fourier transform program and relaxation time measurement capability, magnetic resonance imaging system 22 uses the analytical capability of system 22 to detect changes in the nuclear

magnetic resonance (NMR) spectral parameters (including the relaxation times) derived from the region irradiated by the radiotherapy beam of machine 20. Characteristic changes in the local NMR spectral parameters result from the effects of irradiation by the radiotherapy beam on tissue in the region. Consequently, spectrometer and display unit 48 is able to provide three-dimensional information concerning the spatial distribution of the radiotherapy beam from machine 20 on tissue in the subject while the tissue is being treated by the radiotherapy beam. The three-dimensional information is derived from the display of unit 48 and is correlated either by an operator or automatically by a computer (not shown) with information concerning the location of the desired area to be treated, e.g., the position of the cancerous cells in the patient. In response to this correlation, the position of the patient and therefore of the tissue irradiated by the radiotherapy beam is moved by the operator controlling motors 31, 33 and 35 for the position of the treatment couch of machine 20 or by an automatic feedback system (not shown) for controlling couch position.

Detailed Description Paragraph Right (9):
Basically, spectrometer and display unit 48 monitor changes in the nuclear magnetic resonance spectral parameters of the magnetic resonance imaging system 22. These changes in the nuclear magnetic resonance spectral parameters are directly responsive to the effects of irradiation of the cancerous cells being treated by the radiotherapy beam. This information enables real time three-dimensional correlation between the shape, position and intensity of the irradiated volume and the location of the region desired to be treated, i.e., the region containing the cancerous cells.

Detailed Description Paragraph Right (10):
If rf coil 42 includes a superconductor, preferably a high temperature superconductor, cooled to the 77.degree. K temperature of liquid nitrogen, the magnitude of the main magnetic field derived from the coil of assembly 32 can be substantially reduced. This enables the magnetic coil of assembly 32 to be substantially reduced in volume to facilitate retrofitting the winding segments of this coil assembly to radiotherapy machine 20. Preferably, the high temperature superconductor included in coil 42 is made from oriented high temperature superconductor films grown on metal coils with appropriate buffer layers or on planar oxide single crystal substrates.

Detailed Description Paragraph Right (11):
Magnetic resonance imaging system 22 also includes assembly 50 containing DC gradient coils for X', Y' and Z' coordinate axes that are somewhat different from the X', Y' and Z' coordinate axes for the couch of machine 20. The X' and Z' axes are in the horizontal plane but are displaced 45.degree. from the X and Z axes while the vertical Y and Y' axes are coincident. The gradient coils of assembly 50 are supplied with variable amplitude DC currents from source 52 such that at different times the amplitudes of the gradient magnetic fields produced by the coils of assembly 50 vary.

Detailed Description Paragraph Right (12):
The gradient coils of assembly 50 are mounted so the radiotherapy beam is not incident on them and the gradient coils do not interfere with the beam supplied by radiotherapy machine 20 to the subject. To this end, the X' and Z' coils, which are at right angles to the axis of the radiotherapy beam incident on the subject, are mounted on the coils of assembly 32, as described in detail infra. The coils of assembly 50 which establish the Y' axis magnetic field that is either vertical or which extends in the same general direction as the axis of the radiotherapy beam incident on the subject are positioned in different vertical planes or in different planes at right angles to the beam axis and include openings enabling the beam to propagate through them.

Detailed Description Paragraph Right (13):
If machine 20 irradiates the subject with an electron radiotherapy beam, source 52 is pulsed on and off simultaneously with source 36 pulsing the coils of assembly 32 on and off so the magnetic fields derived from the gradient coils are not produced while the electron beam is on. Thereby, the gradient magnetic fields produced by the gradient coils of assembly 50 do not have a tendency to deflect the pulsed electron radiotherapy beam.

Detailed Description Paragraph Right (14):
If machine 20 irradiates the subject with an X-ray radiotherapy beam, magnetic

resonance imaging system 22 also includes DC coils of assembly 54; the coils of assembly 54 are supplied with DC current by source 56. The coils of assembly 54 are arranged, as described infra, to produce magnetic fields to suppress leakage magnetic fields derived from the coils of assemblies 32 and 50 of imaging system 22 so these leakage fields are not coupled to the linear accelerator structure of radiotherapy machine 20. If radiotherapy machine 20 is used exclusively to derive an electron beam, the coils of assembly 54 and DC source 56 are not necessary because the magnetic fields from assemblies 32 and 50 are not on while the linear accelerator of the radiotherapy machine is producing a pulsed electron radiotherapy beam.

Detailed Description Paragraph Right (15):
Controller 24, which can be operated by an operator or automatically in a fully automatic system, includes selector 60, synchronizer 62 and couch position controller 64. Selector 60 supplies signals to couch position controller 64 to activate X, Y and Z axis drive motors 31, 33 and 35 for the patient receiving bed movably mounted on the couch of radiotherapy machine 20 so these drive motors are energized at times while (1) no beam from radiotherapy machine 20 is incident on the subject on the couch; and (2) the coils of assemblies 32 and 50 and the rf coil 42 of imaging system 22 are deactivated. At other times, selector 60 controls synchronizer 62 so radiotherapy beam source 26, if it is an electron beam source, is pulsed on while DC sources 36 and 52 are pulsed off and vice versa. Similarly, pulsed rf source 44 is controlled by synchronizer 62 to be inactive while an electron beam is derived from source 26.

Detailed Description Paragraph Right (16):
Reference is now made to FIGS. 2 and 3 of the drawing wherein radiotherapy machine 20 is illustrated as including housing 100 (that carries radiotherapy beam source 26) and treatment couch 102 on which patient P is located. Patient P includes cancerous tissue region R that is irradiated by radiotherapy beam 104, derived from the radiotherapy beam source of machine 20. Housing 100 includes floor mounted upright compartment 106, floor-mounted pedestal 108 and gantry 110 comprised of vertically extending shoulder 112 to which horizontally extending arm 114 is fixedly mounted. Gantry 110 is rotated about horizontal axis 116 by gantry drive motor 28, fixedly mounted in upright compartment 106. Gantry arm 114 carries linear accelerator 118 and associated electron optics including bending magnet 120 which bends a highly energetic electron beam produced by the linear accelerator. The electron beam propagates in accelerator 118 in the horizontal direction, parallel to axis 116 and is deflected by the electron optics of accelerator 118 along beam axis 122 that is at right angles to axis 116. In some radiotherapy machines, radiotherapy beam 104 is an electron beam while in other radiotherapy machines, the radiotherapy beam is comprised of X-ray photons. In the latter case, X-ray target 124 is positioned in the path of the electron beam derived from the linear accelerator and the electron optics including bending magnet 120.

Detailed Description Paragraph Right (17):
The electron optics for the beam derived by linear accelerator 118 and X-ray optics for the beam derived from X-ray target 124 are such that radiotherapy beam 104 is focused on region R of patient P at the isocenter of the radiotherapy machine where the cancerous tissue to be treated is located. Region R, the region desired to be treated by radiotherapy beam 104, is at the intersection of axes 116 and 122.

Detailed Description Paragraph Right (18):
To assist in positioning region R at the intersection of axes 116 and 122, treatment couch 102 includes fixed floor-mounted platform 126 which carries X axis, Y axis and Z axis motors 31, 33 and 35 for moving patient-carrying bed 128 in three mutually orthogonal directions, such that bed 128 is moved in the horizontal plane in the X and Z axes directions and is moved in the vertical direction along the Y coordinate axis.

Detailed Description Paragraph Right (19):
Radiotherapy machine 20, as previously described, is conventional. In the present invention, wherein magnetic resonance imaging system 22 is included in combination with machine 20, leakage magnetic fields produced by linear accelerator 118 and bending magnet 120 are preferably decoupled from magnetic fields of the magnetic resonance imaging system. To this end, leakage field cancellation DC coils 30 surround linear accelerator 118. Preferably DC coils 30 comprise cancellation coil 130, approximately solenoidal in form, that surrounds accelerator 118 and cancellation coil 133 that surrounds bending magnet 120. Solenoid coil 130 in turn

surrounds an iron sleeve 131 including oppositely disposed end caps 132 between which extends iron tube 134. This provides a magnetic return path for the majority of the leakage field from the focusing solenoid of accelerator 118 and reduces the current required in cancellation coil 130. One of end caps 132 has a central opening through which extend electric leads for supplying power to linear accelerator 118. Tube 134 has an opening aligned with axis 122; the opening in tube 134 has a diameter sufficient to enable the electron beam derived by accelerator 118 to pass in an unhindered manner out of the leakage field cancellation system for the accelerator. Additional openings are provided in endcaps 132 and tube 134 for waveguides, electrical supply leads and coolant.

Detailed Description Paragraph Right (20):
In the embodiment of FIGS. 2 and 3, main DC excitation coil assembly 32, rf coil 42, gradient coils 50 and leakage field suppression coils 54 are fixedly mounted by struts (not shown) on pedestal 108 or the floor carrying the pedestal so movement of these coils is independent of turning of linear accelerator 118 about axis 116. Main DC excitation coil 32 preferably carries rf coil 42, gradient coils 50 and leakage field suppression coils 54.

Detailed Description Paragraph Right (21):
Main excitation coil 32 includes two vertically extending, horizontally spaced winding segments 136 and 138, each having a central opening 137 generally aligned with axis 116. Coil segments 136 and 138 surround patient P and bed 128. Coil segments 136 and 138 produce horizontally extending main DC magnetic field lines 140 that are directed generally at right angles to radiotherapy beam axis 122 and extend through treatment region R of patient P. Coil segments 136 and 138 are spaced from each other so region R is between them. Beam 104 extends between coil segments 136 and 138 so the radiotherapy beam does not intersect any portion of coils 32, rf coil 42, gradient coils 50 or leakage field suppression coils 54.

Detailed Description Paragraph Right (22):
To these ends, as illustrated in FIG. 8, X axis gradient DC coils 142, 143 are positioned at and carried by a pair of diagonally opposite corners of DC excitation coil segments 136 and 138 Z' axis gradient DC coils 144, 145 are positioned at and carried by the remaining pair of diagonally opposite corners of segments 136 and 138. Coils 142-145 are mounted on the center portions of coil segments 136 and 138, at the level of bed 128 to produce in region R horizontally directed DC gradient field lines that are at right angles to each other. Y' axis gradient DC coils 146, 147 are positioned at upper and lower edges of coil segments 136 and 138 to produce vertically directed magnetic field lines through region R. Rf coil 42 is fixedly mounted inside of, and to coils 142-145 to supply an rf field to region R and respond to an rf field coupled back to it from region R after the applied rf field has subsided.

Detailed Description Paragraph Right (23):
To suppress the leakage field produced by coil segments 136 and 138, and thereby confine magnetic field lines 140 to the region between the coil segments so the leakage field does not have an effect on the magnetic field linear accelerator 118, DC field suppression coils 54 are formed as a pair of segmented coil windings 154 and 156, as illustrated in FIG. 10. Segments 154 and 156 are respectively carried by and located outside of coil segments 136 and 138 and have central openings with internal diameters slightly less than the internal diameters of coil segments 136 and 138. Coil segments 152 and 154 have external diameters slightly in excess of the external diameters of coil segments 136 and 138. Coil segments 152 and 154 produce magnetic fields which are directed oppositely to and have a magnitude substantially equal to the leakage fields of winding segments 136 and 138 to provide the desired cancellation; this result is achieved by appropriate DC excitation and winding arrangements of coil segments 152 and 154.

Detailed Description Paragraph Right (24):
Reference is now made to FIGS. 4 and 5 of the drawing, wherein main DC excitation coil assembly 32, rf coil 42, gradient coils 50 and leakage suppression coils 54 are configured substantially the same as illustrated in FIGS. 2, 3. However, in the embodiment of FIGS. 4 and 5, coil assembly 32, rf coil 42, gradient coils 50, and leakage suppression coils 54 are carried by and fixedly attached to gantry 110 so all of these coils rotate about axis 116. To simplify the drawing, in FIGS. 4 and 5 only split winding segments 160 and 162 of coil assembly 32 are illustrated, it being understood that rf coil 42, gradient coils 50 and leakage suppression coils 54 are configured basically the same in the embodiment of FIGS. 4 and 5 as in the

embodiment of FIGS. 2, 3. Winding segments 160 and 162 are fixedly connected to gantry 110 by struts 164 and spaced from each other so patient P and bed 128 are between them.

Detailed Description Paragraph Right (25):
Each of coil segments 160 and 162 includes a central opening 166 having a common axis 164 that is substantially coincident with axis 122 of radiotherapy beam 104 and extends through region R. Winding segments 160 and 162 are wound and energized so that main DC magnetic field lines 168, which extend between the coil segments, are generally in planes parallel to axes 122 and 164.

Detailed Description Paragraph Right (26):
Winding segments 160 and 162 of coil assembly 32, as well as rf coil 42, gradient coils 50 and leakage suppression coils 54, are arranged so beam 104 is not incident on any of these coils or winding segments. Because of the substantial coincidence between axis 164 of openings 166 of winding segments 160 and 162 and radiotherapy beam axis 122, the excitation winding segments of the embodiment of FIGS. 4 and 5 have a smaller center opening than the center opening of the winding segments in the embodiments of FIGS. 2, 3. As a result of the smaller center opening in the embodiments of FIGS. 4 and 5, winding segments 160, 162 supply a higher imaging DC magnetic field strength to region R than winding segments 136, 138 for winding segments having the same size and other characteristics. The embodiment of FIGS. 4 and 5 also enables an operator to have better physical access to patient P than is provided with the configuration of FIGS. 2, 3. Further, the embodiment of FIGS. 4 and 5 is less confining to the patient, to reduce psychological stress on the patient.

Detailed Description Paragraph Right (27):
In accordance with a further embodiment, illustrated in FIGS. 6 and 7, main DC excitation coil 32 includes spaced pancake-like winding segments 170 and 172. Segments 170 and 172 extend parallel to each other and are spaced from each other by an amount sufficient to enable bed 128 and patient P to fit between them. Winding segments 170 and 172 and compensating coils 154 are arranged so that the common axis 178 of rotational symmetry thereof is orthogonal to both radiotherapy beam axis 122 and gantry axis 116 about which linear accelerator 118 turns. Consequently, beam 104 passes without obstruction between winding segments 170 and 172 to obviate the need for a central opening in the winding segments. (In FIGS. 6 and 7, only winding segments 170 and 172 of coil assembly 32 are illustrated, but rf coil 42, gradient coils 50 and leakage compensation coils 54 are fixedly mounted with coil assembly 32, as described supra in connection with FIGS. 2 and 3.) Winding segments 170 and 172 and the coils carried by them are fixedly mounted to gantry 110 by struts 174.

Detailed Description Paragraph Right (28):
Coil winding segments 170, 172 produce main DC magnetic field lines 176 that extend at right angles to radiotherapy beam axis 122. Because there is no central opening in winding segments 170, 172, the strength of the main DC magnetic field produced by winding segments 170, 172 is greater than the main DC magnetic field strengths produced by winding segments 136, 138 or 160, 162 in the embodiments of FIGS. 2 and 3 or FIGS. 4 and 5, for the same characteristics of all three sets of winding segments.

Detailed Description Paragraph Right (29):
All of winding segments 170, 172, rf coil 42, gradient coils 50 and leakage field suppression coils 54 are arranged in each of the embodiments of FIGS. 2 and 3, 4 and 5 and FIGS. 6 and 7 such that radiotherapy beam 104 is not incident on any portions thereof. If the radiotherapy beam were incident on any portions of the coils, secondary X-rays would be produced with detrimental effects on patient P. In addition, there would be an inefficient waste of the radiotherapy beam energy on the incident coil parts.

Detailed Description Paragraph Right (30):
In the embodiments of FIGS. 4 and 5 and 6 and 7, wherein the coils are mounted on gantry 110 so the coils rotate with the gantry about axis 116, the angular position of coils 32 can be determined at all times. This result is achieved by monitoring the angular position of gantry 110 by mounting a conventional angular position detector (not shown) on the gantry about axis 116. The angular position detector for gantry 100 supplies a signal indicative of gantry angular position to spectrometer and display unit 48. Unit 48 responds to the signal indicative of gantry, angular position to compensate for variations in the magnetic field established by coil 32

as the coil is turned to different angular positions about axis 116.

Detailed Description Paragraph Right (31):
One possible problem with the embodiment of FIGS. 6 and 7 is that it is difficult for patient P to get on and off bed 128 between spaced winding segments 170 and 172. To solve this problem, winding segments 170 and 172 are physically mounted as illustrated in the top view of FIG. 9, wherein the strut 174 which carries winding segment 170 is mounted so the strut and winding segment can selectively pivot about vertical axis 180. To this end, gantry 110 includes shoulder 182 on which one leaf of hinge 184 is fixedly mounted. The other leaf of hinge 184 is fixedly mounted to strut 174 that carries winding segment 170. In normal operation, when current is applied to winding segments 170, 172, hinge 184 is maintained in place by locking mechanism 186. Prior to patient P beginning treatment by beam 104 or when treatment has been completed, locking 30 mechanism 186 is released and winding segment 170 is swung open so patient P can move on to and off of bed 124.

Detailed Description Paragraph Right (32):
Winding segment 172, maintained in a fixed position at all times on gantry 110, carries both of the Y' axis gradient coils 186, 187 of assembly 50 and X' and Z' axes gradient coils of assembly 50; the other two X' and Z' axis gradient coils 183 and 185 are carried by winding segment 170, in a manner described supra in connection with FIG. 8.

Detailed Description Paragraph Right (33):
The problem of patient P gaining access to and getting off of the patient bed of radiotherapy machine 20 in a confined magnetically-shielded treatment enclosure because of a close position between the enclosure and the winding segments of coil assembly 32 can be resolved by the apparatus illustrated in FIGS. 11 and 12. In the apparatus of FIGS. 11 and 12, patient P gets on bed 188 at a position remote from radiotherapy machine 20. Coils 32, 42, 50 and 52 of magnetic resonance imaging system 88 are carried by bed 188. After patient P is placed on bed 188 at the remote position, the bed is wheeled into place so that region R desired to be treated is positioned along axis 122 of radiotherapy machine 20. The bed is rolled from a preparation, bed mounting position to the treatment position at the isocenter of machine 20 and system 22. To precisely control the bed position, and, therefore, the position of patient P relative to radiotherapy beam axis 122 and gantry rotation axis 116, bed 188 is rolled along non-magnetic tracks 190. When bed 188 has been rolled into the correct position, the bed is locked onto fixed pedestal 108 of machine 20.

Detailed Description Paragraph Right (34):
Then electric and mechanical connections are established between pedestal 108 and yoke 192 at the head of bed 188. The mechanical connections lock bed 188 to pedestal 108 and the electrical connections provide power from power supplies in housing 100 to coils 32, 42, 50, 52 and signals from signal sources in housing 100 to motors 31, 33 and 35 as well as to coil 42. Power for imaging and treating is initiated by an operator after region R has been positioned at the intersection of axes 116 and 122 by the operator activating motors 31, 33 and 35.

Detailed Description Paragraph Right (35):
A single patient bed 188 can shuttle back and forth between a single position external radiotherapy treatment machine 20 or several such beds 188 can shuttle between several external stations and a single treatment machine, as illustrated in FIG. 12. The use of several external positions and several patient beds has the advantage of enabling the treatment machine to have a greater useful cycle time, i.e., a higher duty cycle.

Other Reference Publication (1):
Article by Magin et al., entitled "Miniature Magnetic Resonance Machines", published in IEEE Spectrum on Oct. 1997, pp. 51-61.

CLAIMS:

1. In combination, a radiotherapy machine for deriving a radiotherapy bear for a region of a subject on a treatment couch, and a magnetic resonance imaging system for imaging the region and volumes abutting the region substantially simultaneously with the region being irradiated by the beam, the imaging system including a magnetic excitation coil assembly, the magnetic excitation coil assembly including first and second spaced segments on opposite sides of the region so an axis of the

beam is between the first and second segments, the beam being arranged to be propagated along a beam axis, the beam axis being arranged to turn about another axis arranged to approximately extend through the region and approximately intersect the beam axis, the magnetic excitation coil assembly being mounted independently of movement of the beam axis.

2. The combination of claim 1, further including a treatment couch for the subject, the couch including a bed for holding the subject, the bed being movable for enabling the region to be positioned relative to the treatment beam axis.

3. The combination of claim 1, wherein the first and second segments have a common axis substantially coincident with the another axis, the first and second segments deriving main magnetic field lines that extend between the first and second segments in the same general direction as the common axis, a subject holding structure fitting between generally aligned central openings in the first and second segments along the common axis.

4. The combination of claim 1, wherein the first and second segments have a common axis substantially at right angles to the another axis, the first and second segments being arranged so a subject holding structure is between them, the segments producing a main magnetic field having flux lines extending generally in the direction of the common axis.

5. The combination of claim 1, wherein the beam axis and the first and second segments are arranged so the beam axis extends through a space between the first and second segments and generally at right angles to magnetic field flux lines extending between said first and second segments.

6. The combination of claim 1, further including a magnetic shield structure arranged to decouple magnetic fields originating in the radiotherapy machine from magnetic fields originating in the magnetic resonance imaging system.

8. The combination of claim 6, wherein the shield structure includes: a coil surrounding sources of leakage magnetic fields originating in the magnetic resonance imaging system, and a power source arranged to electrically excite the coil surrounding sources of magnetic fields originating in the magnetic resonance imaging system.

11. The combination of claim 1, wherein the magnetic resonance imaging system includes a coil for deriving a main DC magnetic field, the coil being a non-superconducting wire wound water cooled coil.

12. The combination of claim 1, wherein the magnetic resonance imaging system includes a coil for deriving a main DC magnetic field, the coil being a superconductor.

16. The combination of claim 1, wherein the magnetic resonance imaging system includes a superconducting rf coil.

17. The combination of claim 1, further including a non-magnetic subject carrying structure, the structure being movable to a first region where the machine is located from a second region outside of the first region and the structure being arranged to be locked in said first region.

18. The combination of claim 17, further including a non-magnetic track at the machine for guiding movement of the structure.

21. The combination of claim 1, further including a subject carrying structure, the magnetic excitation coil assembly being positioned to prevent facile access by the subject to and from the structure, a portion of the coil assembly being moveable relative to the structure when the coil assembly is not operative, the coil assembly being moveable to a position facilitating access by the subject to the structure.

22. The combination of claim 21 wherein a coil portion is mounted in a plane extending substantially at right angles to a subject receiving surface of the subject carrying structure, the coil portion being pivotable about an axis extending in the direction of the plane.

23. The combination of claim 21, further comprising motors arranged to control the

relative position of the region and the beam by controlling the position of a subject carrying structure relative to an axis of the beam.

24. The combination of claim 1, further comprising a detector responsive to changes in an output of the magnetic resonance imaging system resulting from protons of atoms in the region precessing at a frequency determined by magnetic resonance excitation thereof and subject to de-execution under the influence of radiation products of said beam.

25. In combination, a radiotherapy machine for deriving a radiotherapy beam for a region of a subject on a treatment couch, and a magnetic resonance imaging system for imaging the reaction and volumes abutting the region substantially simultaneously with the region being irradiated by the beam, the imaging system including a magnetic excitation coil assembly, the magnetic excitation coil assembly including first and second spaced segments on opposite sides of the region so an axis of the beam is between the first and second segments, the beam being arrange to be propagated along a beam axis, the beam axis being arranged to turn about another axis arranged to approximately extend through the region and approximately intersect the beam axis, the magnetic excitation coil assembly being mounted so it moves with movement of the beam axis.

26. The combination of claim 25, wherein each of the first and second segments has a central opening including a common axis, the beam axis extending through the central openings of the first and second segments and being generally aligned with the magnetic field flux lines extending between said first and second segments.

27. In combination, a radiotherapy machine for deriving a radiotherapy electron beam for a region of a subject on a treatment couch, and a magnetic resonance imaging system, including a magnetic excitation coil assembly, for imaging the region and volumes abutting the region substantially simultaneously with the reaction being irradiated by the beam, the substantially simultaneous imaging and beam irradiation being each that the radiotherapy electron beam is arranged to be alternately applied to and removed from the region while a magnetic field from the coil assembly is respectively removed from and applied to the region.

28. In combination, a radiotherapy machine for deriving a radiotherapy electron beam for a region of a subject on a treatment couch, and a magnetic resonance imaging system for imaging the region and volumes abutting the region substantially simultaneously with the region being irradiated by the beam, the magnetic resonance imaging system including a superconductor coil for deriving a main DC magnetic field, a liquid helium source for cooling the superconductor coil to a liquid helium temperature, the substantially simultaneous imaging and beam irradiation being such that the radiotherapy electron beam is alternately applied to and removed from the region while current applied to the coil is arranged to be alternately turned off and on, respectively, and further including superconducting leads for applying current pulses to the coil, the superconducting leads being leads having a high superconducting temperature compared to the temperature of liquid helium.

L8: Entry 14 of 40 File: USPT May 4, 1999

DOCUMENT-IDENTIFIER: US 5899857 A
TITLE: Medical treatment method with scanner input

ABPL:
A noninvasive medical treatment system includes a support for supporting a patient in a predetermined position and a frequency generator for generating essentially monochromatic electromagnetic energy of a frequency selected from a plurality of different treatment frequencies predetermined to selectively destroy organic molecules of respective types specific to a plurality of different kinds of human tissue. A selector is operatively connected to the frequency generator for selecting the one frequency from among the different treatment frequencies produceable by the frequency generator. The system further comprises radiation transmission and guidance components disposed between the frequency generator and the support for directing the energy from the frequency generator to predetermined target tissues internal to the patient supported on the support and for concentrating the energy on the target tissues. A scanner is disposed proximate to the support for obtaining three-dimensional data as to an organic structure internal to the patient so as to enabling a positional tracking of the target region. The scanner including means for continually updating the three-dimensional data during a medical treatment procedure. A computer is operatively connected to the scanner for continually monitoring location and shape of the organic structure during the medical treatment procedure. The computer is operatively connected to at least one of the frequency generator, the transmission and guidance components, and the support for controlling that element in response to the three-dimensional data from the scanner during the medical treatment procedure so that the energy impinges on the target tissues for sufficient time to effectively eradicate the target tissues, whereby the medical treatment procedure is performed despite movement of the organic structure during the medical treatment procedure.

BSPR:
This invention relates to a medical treatment system. More particularly, this invention relates to a medical treatment system with scanner input. Even more particularly, this invention relates to an automatic treatment system with control based upon scanner input. This invention also relates to an associated method.

BSPR:
Substantial advances have been made in the last twenty years in ascertaining internal organic structures without surgery. CAT scanners and nuclear magnetic resonance (NMR) imaging devices, as well as ultrasonography, have provided the physician with powerful tools for use in diagnosing patients. For the most part, these scanners have been used solely in medical examinations and diagnosis. However, radiological treatment of brain tumors has used imaging equipment to locate target tumors and to direct radiation to the target location. In addition, U.S. Pat. No. 5,207,223 discloses the directing of a necrosis-causing X-ray beam to cancerous target tissues upon the locating of the target tissues by the comparison, with reference data, of electronic images garnished by diagnostic beams.

BSPR:
Another object of the present invention is to provide such a technique and/or such a system which utilizes data obtained with a three-dimensional scanning apparatus.

BSPR:
A noninvasive medical treatment system comprises, in accordance with the present invention, a support for supporting a patient in a predetermined position and a frequency generator for generating essentially monochromatic electromagnetic energy of a frequency selected from a plurality of different treatment frequencies predetermined to selectively destroy organic molecules of respective types specific to a plurality of different kinds of human tissue. A selector is operatively connected to the frequency generator for selecting the one frequency from among the different treatment frequencies produceable by the frequency generator. The system further comprises radiation transmission and guidance components disposed between the

frequency generator and the support for directing the energy from the frequency generator to predetermined target tissues internal to the patient supported on the support and for concentrating the energy on the target tissues. A scanner is disposed proximate to the support for obtaining three-dimensional data as to an organic structure internal to the patient so as to enabling a positional tracking of the target region. The scanner including means for continually updating the three-dimensional data during a medical treatment procedure. A computer is operatively connected to the scanner for continually monitoring location and shape of the organic structure during the medical treatment procedure. The computer is operatively connected to at least one of the frequency generator, the transmission and guidance components, and the support for controlling that element in response to the three-dimensional data from the scanner during the medical treatment procedure so that the energy impinges on the target tissues for sufficient time to effectively eradicate the target tissues, whereby the medical treatment procedure is performed despite movement of the organic structure during the medical treatment procedure.

BSPR:
In accordance with a feature of the present invention, the computer includes means for identifying a location and a shape of the organic structure after a shift of the organic structure, based upon the three-dimensional data from the scanner. The computer exemplarily contains an identification module formed by generic computer circuit as modified by programming. The computer further includes a coordinate determination module for determining a change in positional coordinates of the target tissues due to the shift of the organic structure and for determining an operational modification of the controlled element (one of the frequency generator, the transmission and guidance components, and the support) for delivering the energy to the target tissues after the shift of the organic structure.

BSPR:
In other kinds of operations, involving a slow movement of an internal organ such as the colon, the computer can move the support to realign the target region with the focal point of the radiation transmission and guidance components. Alternatively, the focusing element(s) may be actuated to adjust the focal point of the radiation to coincide with the shifted target region.

BSPR:
In accordance with another feature of the present invention, one or more photodetectors are disposed proximately to the support for sensing electromagnetic radiation emitted from the target tissues in response to excitation thereof by the selected treatment frequency. The computer is operatively connected to the photodetector(s) for detecting a change in spectral output of the target tissues in response to the selected treatment frequency and for interrupting the directing of the selected treatment frequency to the target tissues upon detecting such a change.

BSPR:
In a more specific embodiment of the invention, the frequency generator is capable of generating essentially monochromatic electromagnetic energy of two frequencies simultaneously, the selector being operatively connected to the frequency generator for selecting the two frequencies from among the different treatment frequencies produceable by the frequency generator. The transmission and guidance components are disposed between the frequency generator and the support for directing the two frequencies from the frequency generator to the predetermined target tissues internal to the patient supported on the support and for concentrating the energy on the target tissues.

BSPR:
A medical treatment method comprises, in accordance with the present invention, the steps of (a) supporting a patient in a predetermined position, (b) automatically scanning the patient, (c) determining, in response to the step of scanning, positional coordinates of a three-dimensional target region which is internal to the patient, (d) operating a frequency generator to (I) select a predetermined frequency from among a plurality of different treatment frequencies produceable by the frequency generator and predetermined to be absorbable by organic molecules of respective types specific to a plurality of different kinds of human tissue and (ii) to generate essentially monochromatic electromagnetic energy of the selected treatment frequency, (e) directing the predetermined frequency to the target region, in accordance with the positional coordinates, (f) concentrating the predetermined frequency on the target region, (g) continuing to automatically scan the patient, and (h) automatically ceasing the directing of the predetermined frequency to the target region upon detecting a change in location of target region in response to the continued automatic scanning of the patient.

BSPR:
In one procedure pursuant to the invention, the method further comprises

automatically determining new positional coordinates of the target region after the change in location thereof, automatically redirecting the predetermined frequency to the changed location of the target region in accordance with the new positional coordinates, and concentrating the predetermined frequency on the changed location of the target region.

BSPR:
In one procedure pursuant to the invention, the method further comprises automatically determining when the target region has again attained the positional coordinates after the change in location of the target region, automatically redirecting the predetermined frequency to the target region when the target region has again attained the positional coordinates, and again concentrating the predetermined frequency on the target region when the target region has again attained the positional coordinates.

BSPR:
A system and method in accordance with the present invention utilizes data obtained with a continuous scanning apparatus. Thus, the gathering of information and the control of surgical operations may be at least partially automated.

DEPR:
As illustrated in FIG. 1, a medical treatment system comprises a support 12 for supporting a patient P in a predetermined position and a plurality of radiation generators 14 and 16 for generating essentially monochromatic electromagnetic energy having one or more distinct frequencies in the microwave, near millimeter, infrared, optical, ultraviolet regions of the electromagnetic spectrum. Each radiation generator 14 and 16 is connected via a wave guide 18 or 20 to a respective focusing device or lens 22 or 24. Lenses 22 and 24 are disposed between the respective radiation generator 14 and 16 and patient support 12 for concentrating the electromagnetic treatment frequency or frequencies, e.g., microwaves ME1 and ME2, on a predetermined focal point FP internal to a target region TR inside patient P.

DEPR:
A computer 28 is operatively connected to a CAT scanner or NMR type imaging apparatus 30, possibly supplemented with ultrasonic imaging, juxtaposed to patient support 12. Scanner 30 provides computer 28 with continuously updated three-dimensional structural data as to the organs of patient P surrounding target region TR.

DEPR:
Computer 28 is also connected to peripheral output devices such as a monitor 46 and a printer 48 (FIG. 1) for communicating to an operator, e.g., a surgeon, the results of three-dimensional scans of patient P. Computer 28 receives additional input from a keyboard 32 and possible other devices such as a mouse (not illustrated). Viewing three-dimensional scanned organic structure of patient P on monitor 46 and/or on a print-out from printer 48, the surgeon or other operator selectively defines target region TR of patient P via keyboard 32 and the other instruction input devices (not shown) operatively linked to computer 28.

DEPR:
Target region TR may be additionally or alternatively defined by computer 28 in accordance with programming for the automatic identification of internal organic structures based on such previously defined parameters as shape, texture, density, and location relative to other organs. More specifically, computer 28 may automatically identify the location and general shape of a possible target region, the identification being implemented, for example, by a color coded outline on monitor 46. The surgeon then uses keyboard 32 and/or other input devices to more precisely define the boundaries of target region TR.

DEPR:
As an alternative or supplement to relocation control units 34 and 36, a shifting mechanism 38 is connected to patient support 12 and computer 28 for shifting the position of the patient P under the control of computer 28, thereby changing the location of the focal point FP relative to patient P.

DEPR:
As illustrated in FIG. 2, computer 28 includes several functional modules which are implemented by generic processor circuits modified by programming to perform specific functions. In particular, computer 28 includes a target tracking module 50 for monitoring and continually updating the location of the predefined target region TR. Target tracking module 50 thus enables the completion of an operation on an internal organ containing the target region TR despite movement or reconfiguration of the organ due to (generally) involuntary muscular contractions of the patient. Target tracking module 50 receives continually updated three-dimensional structural data directly from scanner 30, as well as organ location and shape information from an

organ identifier module 52 which is connected at an input to scanner 30. Identifier module 52 accesses a memory 54 for reference data to compare with the real-time three-dimensional data from scanner 30.

DEPR:
Target tracking module 50 is connected at an input to a target definition module 56 which receives instructions from keyboard 32 for defining target region T. Target definition module 56 is also connected to memory 54 and to scanner 30 for enabling a definition of target region TR by computer 28 in accordance with programming for the automatic identification of internal organic structures based on such previously defined parameters as shape, texture, density, and location relative to other organs.

DEPR:
Target tracking module 50 detects when target region TR shifts from an initial location and signals a radiation process control module 58 which then terminates or interrupts the transmission of the selected treatment frequency or frequencies to the patient. To that end, control module 58 is connected to a frequency selector module 60 in turn connected to frequency generators 14 and 16 (FIG. 1) for arresting the emission of the selected treatment frequency or frequencies from frequency generators 14 and 16. Frequency selector module 60 also implements the selection of the different frequencies, for example, one frequency to be produced by generator 14 and another frequency to be produced by generator 16. Frequency selector module 60 additionally implements the setting of treatment parameters including rate of pulsing of the selected treatment frequency or frequencies, the interpulse interval, the pulse duration and the intensity of the radiation. If computer 28 automatically selects the values of radiation parameters radiation process control module 58 sets the parameter values in accordance with instructions communicated via keyboard 32 and treatment tables contained in a memory 62.

DEPR:
Target tracking module 50 can automatically determine new positional coordinates of target region TR after a change in location thereof This function is particularly useful where internal muscle contractions and other organ movements cause an effectively permanent shift of the target region from the original location. In this case, in response to signals from target tracking module 50, control module 58 automatically redirects the selected treatment frequency or frequencies to the changed location of target region TR in accordance with the new positional coordinates and concentrates the selected treatment frequency or frequencies on the changed location of the target region. Radiation process control module 58 is operatively connected to a lens operation module 64 which is in turn linked to focal point relocation controls 34 and 36 for modifying the focal points of lenses 22 and 24 in response to signals from module 58. A support positioning module 66 is connected to process control module 58 and shifting mechanism 38 for inducing the repositioning of support 12 in accordance with signals from module 58.

DEPR:
A plurality of wireless signal emitters 68 are optionally attached to support 12 for providing computer 28 with reference points for use by target tracking module 50 and organ identifier module 53 to triangulate position coordinates of target region TR and the associated organ. Detectors 70 sense the signals produced by emitters 68 and communicate spatial locations to target tracking module 50 and organ identifier module 52.

DEPR:
As described in U.S. Pat. No. 5,429,144, the disclosure of which is hereby incorporated by reference, the myocardium can be effectively revascularized by inserting stents directly into the myocardium from the left ventricle. The stents define passages or channels which extend from the left ventricle and terminate in the heart wall, thereby enabling the delivery of oxygenated blood from the left ventricle directly to the myocardium, bypassing a blocked coronary artery. In accordance with the disclosure of U.S. Pat. No. 5,429,144, the recesses or channels are formed in the myocardium through the use of intravascular catheters. Those recesses or channels for revascularizing the myocardium may be formed noninvasively with the apparatus of FIG. 1. In such a procedure, target tracking module 50 alerts process control module 58 when the target region, a predefined part of the myocardium, returns to initial position coordinates. Module 58 then automatically redirects the selected treatment frequency or frequencies to the target region. Generally, a target region in the myocardium is irradiated during diastole, i.e., when the heart is relaxed between successive contractions. The myocardium-revascularizing channels or recesses formed in this procedure are capable of remaining open without the use of stents. It may be necessary to perform the radiation-mediated noninvasive operation several times on successive occasions to ensure that the channels remain open. The locations of the channels formed in a patient's heart wall will be stored by computer 28 for possible

use by target definition module 56 in subsequent operatior

DEPR:
The radiological treatment apparatus of FIG. 1 optionally includes a photodetector assembly or spectrometer assembly 26 comprising a plurality of individual photodetectors or scanning spectrometers 26a, 26b, 26c, 26d disposed proximately to patient support 12 for detecting electromagnetic radiation ER from the patient P. Radiation ER is emitted from organic cellular material at focal point FP in response to excitation of the cellular material by the treatment frequency or frequencies, e.g., microwaves ME1 and ME2. Generally, some of the target molecules in target region TR which absorb the incoming microwaves ME1 and ME2 are excited to photoluminesce and emit radiation ER. A part of radiation ER escapes through overlying organic tissues of the patient P and is detectable by photodetector assembly or spectrometer assembly 26.

DEPR:
Computer 28 includes a spectrographic analysis module 72 which is operatively connected to photodetector assembly 26 for analyzing the signals from the photodetector assembly to ascertain a spectral output of the organic cellular material which luminesced at focal point FP. Inasmuch as the spectral content of the escaping radiation ER is differentially modified by the tissues through which the radiation passes, computer 28 is programmed to approximate the original spectral content of the radiation emitted by the excited molecular or cellular material at focal point FP. To that end, computer 28 is previously programmed to store, in a memory 74, known absorption spectra for different kinds of tissue. In addition, spectrographic analysis module 72 is provided with three-dimensional structural data from scanner 30 and organ shape and location information from organ identifier module 52 as to the organs of patient P surrounding target region TR. From the kinds and thicknesses of the tissues between focal point FP and a respective unit 26a, 26b, 26c, or 26d of photodetector assembly 26, computer 28 is able to reconstruct the original spectral content of the radiation ER emitted in a photoluminescence process by the excited organic material at focal point FP. Photodetector assembly 26 may include an array of individual photodetectors (not shown), as described in U.S. Pat. No. 5,305,748, the disclosure of which is hereby incorporated by reference.

DEPR:
Casing 156 is optionally provided with a plurality of input ports 168a and 168b containing respective photodetectors 170a and 170b (FIG. 4) or optical elements (not shown) for transmitting incoming radiation to the photodetectors.

DEPR:
Electromagnetic frequency generators 172a and 172b may be laser sources producing output radiation transmitted along optical fibers of cable 152 (FIG. 3) to collimating lenses 180a and 180b, e.g., in casing 154, upstream of directional reflectors 174a and 174b. At any one time, generators 172a and 172b may produce the same frequency. In that case, radiation 160a and 160b combine at the target point TP to provide a sufficient intensity for not only for stimulating or exciting organic molecules within test region TRG but for degrading and destroying those molecules. The location of target region TRG or target point TP is determinable by a scanner such as scanner 30 in FIG. 1. Alternatively, an optical scanner with pattern recognition (see FIG. 5) may function in combination with an ultrasonic or infrared distance scanner (FIG. 5) to automatically determine the location of target region TRG or target point TP. The scanned is operatively connected to computer 178 for providing the computer with three-dimensional structural data pertaining to the patient's internal organs. As discussed above with reference to FIGS. 1 and 2, computer 178 includes modules for tracking target point TP and automatically halting the transmission of treatment frequencies in the event of a shift in location or shape of an internal organ containing target point TP. Additionally, the target point tracking module of computer 178 enables the computer to continually or periodically transmit a treatment frequency or frequencies to target point TP despite a movement of the target point and output ports 158a and 158b relative to one another.

DEPR:
The transmission of multiple treatment frequencies, which impinge upon the same organic tissues only at the target point TP, can provide information to computer 178 as to the location of the organic tissues, as described in greater detail hereinafter with reference to FIG. 5. Computer 178 is provided with feedback 182a and 182b as to the angles of directional transmission reflectors 176a and 176b, thereby enabling computation of the location of test region TRG. Components in FIG. 5 which are the same as components in FIG. 4 bear the same reference designations. FIG. 5 shows additional componentry for enhancing the operation of the medical investigative and diagnostic system of FIGS. 3 and 4.

DEPR:

To further facilitate this locating process, a distance sensing unit or scanner 196 is disposed in hand held unit 150 and is connected to computer 178. Distance sensing unit or scanner 196 incorporates ultrasonic or infrared distance sensors (not separately illustrated) to automatically determine the distance of the patient PT from casing 156. Concomitantly, computer 178 is able to determine the location of test region TRG or test point TP within the patient from the information regarding the location of the patient relative to hand held unit 150 and the location of the test region TRG relative to the hand held unit.

DEPR:
Further locating componentry in the form of a wide angle camera (e.g., a charge coupled device or CCD) 198 may be provided on hand held unit 150. Camera 198 is connected to a pattern recognition circuit 200 and a position identification component 202 which cofunction to determine over what part of the patient PT point TP is located. Pattern recognition circuit 200 and position identification component 202 are incorporated into or connected to computer 178 for facilitating the locating function thereof.

DEPR:
Computer 178 may select intensity or amplitude measurement results which conform to a modulation signal, as sensed by amplifier 192. In additional, a polarization detector or analyzer 208 with concentrating input elements 210 is connected to an input of computer 178 for providing the computer with data pertaining to the polarization characteristics of incoming radiation arriving from irradiated regions of the patient.

DEPR:
The transmission of multiple treatment frequencies, which impinge upon the same organic tissues only at the target point PT, can provide information to computer 178 as to the location of the organic tissues, as described in greater detail hereinafter. Computer 178 is provided with feedback 182a and 182b as to the angles of directional transmission reflectors 176a and 176b, thereby enabling computation of the location of test region TRG.

DEPR:
As discussed hereinabove with reference to FIGS. 3 and 4, the investigative system may transmit two different frequencies through a patient to a target point TP or test region TRG. Each frequency or radiation beam 160a and 160b is transmitted along its respective line or path 162a and 162b. Lines 162a and 162b extend through the patient at angle a1 relative to one another. The angle a1 is determinable by computer 178 by input 182a and 182b regarding the orientations of directional reflectors or transmitters 174a and 174b. Frequencies or radiation beams 160a and 160b are transmitted simultaneously.

DEPR:
The determination of which treatment frequencies are to be used for performing a particular operation on selected target tissues is made in accordance with information as to tissue spectral responses. These spectral responses are collected as described in U.S. Pat. No. 5,482,041, the disclosure of which is hereby incorporated by reference.

CLPV:
supporting a patient in a predetermined position;

CLPV:
determining, in response to said step of scanning, positional coordinates of a three-dimensional target region which is internal to the patient and which contains target tissues;

CLPV:
directing the electromagnetic energy of the selected treatment frequency to said target region, in accordance with said positional coordinates;

CLPV:
automatically determining positional coordinates of a new target region after the shift of the target tissues;

CLPV:
automatically determining when the target tissues have again attained said positional coordinates after the shift of the target tissues;

CLPV:
automatically redirecting said selected treatment frequency to said target region when the target tissues have again attained said positional coordinates; and

CLPV:
again concentrating said selected treatment frequency on said target region when the target tissues have again attained said positional coordinates.

CLPV:
simultaneously directing said first selected treatment frequency and said second selected treatment frequency to said target region, in accordance with said positional coordinates; and